

**UNDER GRADUATE ( B.Tech.) SYLLABUS 2021-2023 Admission Batches****Third Semester**

|                                   |                                                                                                                                                                                                                          |              |                 |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------|
| Name of Program                   | B.Tech (Electronics & communications)                                                                                                                                                                                    | Semester-III | Session 2021-22 |
| Name of Course                    | Mathematics-3                                                                                                                                                                                                            |              |                 |
| Course Code                       | MTH-231                                                                                                                                                                                                                  |              |                 |
| Core / Elective / Other           | Core                                                                                                                                                                                                                     |              |                 |
| Prerequisite:                     |                                                                                                                                                                                                                          |              |                 |
| 1.                                | Knowledge of Engineering Mathematics upto B.Tech. I year                                                                                                                                                                 |              |                 |
| 2.                                | Basic knowledge of probability                                                                                                                                                                                           |              |                 |
| Course Outcomes:                  |                                                                                                                                                                                                                          |              |                 |
|                                   | Apply suitable numerical techniques for real-world problem related to Electronics & Communication Engineering                                                                                                            |              |                 |
| Description of Contents in brief: |                                                                                                                                                                                                                          |              |                 |
| 1.                                | Mean, median, mode and standard deviation, Correlation and regression analysis.                                                                                                                                          |              |                 |
| 2.                                | Combinatorial probability, probability distribution functions-binomial, Poisson, exponential and normal, Joint and conditional probability                                                                               |              |                 |
| 3.                                | Introduction to group theory, vector spaces, subspaces, algebra of subspaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces, Diagonalization of a matrix. |              |                 |
| 4.                                | Numerical solutions of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration                                                                                    |              |                 |
| 5.                                | Numerical solution of initial value problems of ODEs: Euler's method, Runge-Kutta methods, convergence criteria.                                                                                                         |              |                 |
| List of Text Books:               |                                                                                                                                                                                                                          |              |                 |
| 1.                                | Numerical Methods by Dr. B. S. Grewal                                                                                                                                                                                    |              |                 |
| 2.                                | Mathematical Statistics-Ray, Sharma and Chaudhary                                                                                                                                                                        |              |                 |
| 3.                                | Advanced Engineering Mathematics by Erwin Kreyszig                                                                                                                                                                       |              |                 |
| 4.                                | Linear Algebra and Its Applications- Gilbert Strang                                                                                                                                                                      |              |                 |
| List of Reference Books:          |                                                                                                                                                                                                                          |              |                 |
| 1.                                | Introduction to Mathematical Statistics-Hogg, R. V. and Craig, A., Pearson Education, 6th edition 2006.                                                                                                                  |              |                 |
| 2.                                | Linear Algebra- Hoffman, K. and Kunze, R., 2nd edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India 2004.                                                                                                  |              |                 |
| 3.                                | Contemporary Abstract Algebra- Gallian J. A., 8th edition Cengage Learning 2013.                                                                                                                                         |              |                 |
| 4.                                | Applied Numerical Analysis- Gerald, C. F. and Wheatly, P. O., 6th edition, Wesley 2002.                                                                                                                                  |              |                 |
| 5.                                | Numerical Methods for Scientific and Engineering Computation- Jain, M. K., Iyengar, S. R. K. and Jain, R. K., New Age Pvt. Publisher, New Delhi 2000.                                                                    |              |                 |
| URLs:                             |                                                                                                                                                                                                                          |              |                 |
| 1.                                | <a href="https://nptel.ac.in/courses/111/107/111107105/">https://nptel.ac.in/courses/111/107/111107105/</a>                                                                                                              |              |                 |

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| 2.                                   | <a href="https://nptel.ac.in/courses/111/105/111105041/">https://nptel.ac.in/courses/111/105/111105041/</a> |        |              |
| 3.                                   | <a href="https://nptel.ac.in/courses/111/105/111105112/">https://nptel.ac.in/courses/111/105/111105112/</a> |        |              |
| Lecture Plan (about 40-50 Lectures): |                                                                                                             |        |              |
| Lecture No.                          | Topic                                                                                                       |        |              |
| 1.                                   | Average of central tendency as Mean, median and mode                                                        |        |              |
| 2.                                   | Problems based on Mean, median and mode                                                                     |        |              |
| 3.                                   | Problems based on Mean, median and mode                                                                     |        |              |
| 4.                                   | Combinatorial probability                                                                                   |        |              |
| 5.                                   | Probability distribution functions                                                                          |        |              |
| 6.                                   | Probability distribution functions Poisson Distribution                                                     |        |              |
| 7.                                   | Problems on Poisson Distribution                                                                            |        |              |
| 8.                                   | Exponential Distribution                                                                                    |        |              |
| 9.                                   | Normal Distribution                                                                                         |        |              |
| 10.                                  | Joint and conditional probability                                                                           |        |              |
| 11.                                  | Problems based on Joint and conditional probability                                                         |        |              |
| 12.                                  | Problems based on Joint and conditional probability                                                         |        |              |
| 13.                                  | Correlation & regression                                                                                    |        |              |
| 14.                                  | Problems on Correlation & regression analysis                                                               |        |              |
| 15.                                  | Introduction to group theory                                                                                |        |              |
| 16.                                  | Based problem on group theory                                                                               |        |              |
| 17.                                  | Vector spaces                                                                                               |        |              |
| 18.                                  | Examples of Vector space                                                                                    |        |              |
| 19.                                  | Subspaces                                                                                                   |        |              |
| 20.                                  | Algebra of subspaces                                                                                        |        |              |
| 21.                                  | Linear combination of vectors                                                                               |        |              |
| 22.                                  | Linear span                                                                                                 |        |              |
| 23.                                  | Linear independence                                                                                         |        |              |
| 24.                                  | Basis & Dimension                                                                                           |        |              |
| 25.                                  | Problems on Basis & Dimension                                                                               |        |              |
| 26.                                  | Dimension of subspaces                                                                                      |        |              |
| 27.                                  | Diagonalization of a matrix                                                                                 |        |              |
| 28.                                  | Problems on Diagonalization of a matrix                                                                     |        |              |
| 29.                                  | Roots of Algebraic and transcendental equations, Bisection Method                                           |        |              |
| 30.                                  | Bisection Method                                                                                            |        |              |
| 31.                                  | Secant Method                                                                                               |        |              |
| 32.                                  | Problems on Secant Method                                                                                   |        |              |
| 33.                                  | Newton Raphson Method                                                                                       |        |              |
| 34.                                  | Newton Raphson Method                                                                                       |        |              |
| 35.                                  | Fixed point iteration                                                                                       |        |              |
| 36.                                  | Numerical solution of initial value problems of ODEs Euler's method                                         |        |              |
| 37.                                  | Problems on Euler's method                                                                                  |        |              |
| 38.                                  | Runge-Kutta methods                                                                                         |        |              |
| 39.                                  | Problems on Runge-Kutta methods                                                                             |        |              |
| 40.                                  | Convergence criteria                                                                                        |        |              |
| Name of Program                      |                                                                                                             | B.TECH | Semester III |
|                                      |                                                                                                             |        | Year II      |

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| <b>Name of Course</b>                                                           | Electronics Circuits and Devices                                                                                                                                                                                                            |
| <b>Course Code</b>                                                              | ECE 211                                                                                                                                                                                                                                     |
| <b>Core / Elective / Other</b>                                                  | Core                                                                                                                                                                                                                                        |
| <b>Prerequisite:</b>                                                            |                                                                                                                                                                                                                                             |
| 1.                                                                              | Semiconductor Devices and Physics                                                                                                                                                                                                           |
| 2.                                                                              | Basic Network Analysis                                                                                                                                                                                                                      |
| 3.                                                                              | Basic Electronics Engineering                                                                                                                                                                                                               |
| <b>Course Outcomes:</b> After completion of the course student will be able to: |                                                                                                                                                                                                                                             |
| 1.                                                                              | Study, Analyses, Design & Compare different types of transistor configurations.                                                                                                                                                             |
| 2.                                                                              | Describe the different Biasing of FETs, MOSFET for their applications.                                                                                                                                                                      |
| 3.                                                                              | Discuss & Construct different Power semiconductor devices like SCR, DIAC, TRIAC, UJT and testing their VI characteristics in laboratory for different applications.                                                                         |
| 4.                                                                              | Demonstrate and interpret different small signal low frequency and high frequency analysis BJT different configurations & discuss different design.                                                                                         |
| 5.                                                                              | Discuss and design different power amplifier for different class to construct & illustrate different class of power amplifiers for real applications.                                                                                       |
| 6.                                                                              | Design, implement & illustrate different wave shaping circuits.                                                                                                                                                                             |
| <b>Description of Contents in brief:</b>                                        |                                                                                                                                                                                                                                             |
| 1.                                                                              | Modeling devices: Static characteristics of ideal two terminal and three terminal devices; Small signal models of non-linear devices.                                                                                                       |
| 2.                                                                              | Introduction to semiconductor equations and carrier statistics: Poisson's and continuity equations, Fermi-Dirac statistics and Boltzmann approximation to the Fermi Dirac statistics                                                        |
| 3.                                                                              | Semiconductor Diodes: Barrier formation in metal semiconductor junctions, PN homo and hetero- junctions; CV characteristics and dopant profiling; IV characteristics; Small signal models of diodes; Some Applications of diodes.           |
| 4.                                                                              | Field Effect Devices : JFET/HFET, MIS structures and MOSFET operation; JFET characteristics and small signal models; MOS capacitor CV and concept of accumulation, depletion and inversion; MOSFET characteristics and small signal models. |
| 5.                                                                              | Bipolar transistors : IV characteristics and Ebers-Moll model; small signal models; Charge storage and transient response.                                                                                                                  |
| 6.                                                                              | Discrete transistor amplifiers : Common emitter and common source amplifiers; Emitter and source followers.                                                                                                                                 |
| <b>List of Text Books:</b>                                                      |                                                                                                                                                                                                                                             |
| 1.                                                                              | Microelectronic Devices- Dipankar Nag Choudhary                                                                                                                                                                                             |
| 2.                                                                              | Fundamentals of semiconductor devices – M K Achuthan, K N Bhat                                                                                                                                                                              |
| 3.                                                                              | Solid State Electronic Devices- D K Bhattcharya, Rajnish Sharma                                                                                                                                                                             |
| <b>List of Reference Books:</b>                                                 |                                                                                                                                                                                                                                             |
| 1.                                                                              | D. A. Neamen, Semiconductor Physics and Devices (IRWIN), Times Mirror High Education Group, Chicago, 1997.                                                                                                                                  |
| 2.                                                                              | E.S. Yang, Microelectronic Devices, McGraw Hill, Singapore, 1988.                                                                                                                                                                           |

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| 3. | B.G. Streetman, Solid State Electronic Devices, Prentice Hall of India, New Delhi, 1995.                 |
| 4. | J. Millman and A. Grabel, Microelectronics, McGraw Hill, International, 1987.                            |
| 5. | A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991.                 |
| 6. | R.T. Howe and C.G. Sodini, Microelectronics : An integrated Approach, Prentice Hall International, 1997. |

**URLs:**

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| 1. | <a href="http://class.ece.iastate.edu/ee230/">http://class.ece.iastate.edu/ee230/</a>                               |
| 2. | <a href="http://inst.eecs.berkeley.edu/~ee130/archives.html">http://inst.eecs.berkeley.edu/~ee130/archives.html</a> |
| 3. | <a href="http://class.ece.iastate.edu/ee330/">http://class.ece.iastate.edu/ee330/</a>                               |

**Lecture Plan (about 40-50 Lectures):**

| Lecture No. | Topic                                                   |
|-------------|---------------------------------------------------------|
| 1.          | Basic introduction about the subject.                   |
| 2.          | Modeling devices                                        |
| 3.          | Static characteristics of ideal two terminal devices.   |
| 4.          | Static characteristics of ideal three terminal devices. |
| 5.          | Small signal models of non-linear devices.              |
| 6.          | Contd. Small signal models of non-linear devices.       |
| 7.          | Introduction to semiconductor equations.                |
| 8.          | Introduction to carrier statistics.                     |
| 9.          | Poisson's equations.                                    |
| 10.         | Continuity equations.                                   |
| 11.         | Fermi-Dirac statistics.                                 |
| 12.         | Contd. Fermi-Dirac statistics.                          |
| 13.         | Boltzmann approximation to the Fermi Dirac statistics.  |
| 14.         | Semiconductor Diodes.                                   |
| 15.         | Barrier formation in metal semiconductor junctions.     |
| 16.         | PN homo-junctions.                                      |
| 17.         | PN hetero-junctions.                                    |
| 18.         | CV characteristics.                                     |
| 19.         | Dopant profiling.                                       |
| 20.         | IV characteristics of FET                               |
| 21.         | Small signal models of diodes.                          |
| 22.         | Some Applications of diodes.                            |
| 23.         | Field Effect Devices : JFET.                            |
| 24.         | Field Effect Devices : HFET.                            |
| 25.         | MIS structures.                                         |
| 26.         | MOSFET operation.                                       |
| 27.         | JFET characteristics.                                   |
| 28.         | Small signal models.                                    |
| 29.         | Bipolar transistors.                                    |
| 30.         | IV characteristics.                                     |
| 31.         | Elers-Moll model.                                       |
| 32.         | Small signal models.                                    |
| 33.         | Charge storage.                                         |
| 34.         | Transient response.                                     |

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| 35. | Discrete transistor amplifiers. |
| 36. | Common emitter.                 |
| 37. | Contd. Common emitter.          |
| 38. | Common source amplifiers.       |
| 39. | Emitter followers.              |
| 40. | Source followers.               |

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| Name of Program                      |                                                                                                                                 | B.Tech                 | Semester III | YearII |
| Name of Course                       |                                                                                                                                 | DIGITAL CIRCUIT DESIGN |              |        |
| Course Code                          |                                                                                                                                 | ECE 212                |              |        |
| Core / Elective / Other              |                                                                                                                                 | Core                   |              |        |
| Prerequisite:                        |                                                                                                                                 |                        |              |        |
| 1.                                   | Basic knowledge of electronic circuits                                                                                          |                        |              |        |
| 2.                                   |                                                                                                                                 |                        |              |        |
| 3.                                   |                                                                                                                                 |                        |              |        |
| Course Outcomes:                     |                                                                                                                                 |                        |              |        |
| 1.                                   | To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. |                        |              |        |
| 2.                                   | To impart how to design Digital Circuits                                                                                        |                        |              |        |
| 3.                                   | To design and analyses synchronous and asynchronous sequential circuits                                                         |                        |              |        |
| Description of Contents in brief:    |                                                                                                                                 |                        |              |        |
| 1.                                   | Number systems, reduction of logical expressions using boolean algebra, k-map and tabulation method                             |                        |              |        |
| 2.                                   | Combinational circuits Design                                                                                                   |                        |              |        |
| 3.                                   | Sequential Circuit Design                                                                                                       |                        |              |        |
| 4.                                   | Registers, Counters, State machines                                                                                             |                        |              |        |
| 5.                                   | Logic families: RTL, DTL, TTL, STTL, ECL, I <sup>2</sup> L, basic gates.                                                        |                        |              |        |
| 6.                                   | parameters of logic Families: fan-in, fan-out , power dissipation, noise margin, delay calculation.                             |                        |              |        |
| List of Text Books:                  |                                                                                                                                 |                        |              |        |
| 1.                                   | M. Moris Mano, Digital Logic and Computer Design, Pearson Education, New Delhi, , 2012                                          |                        |              |        |
| 2.                                   | Zvi. Kohavi, Switching and Finite Automata Theory, Tata McGraw Hill, New Delhi                                                  |                        |              |        |
| 3.                                   | Gupta BR, Digital Electronics, SK Kataria Publishers, 2009                                                                      |                        |              |        |
| List of Reference Books:             |                                                                                                                                 |                        |              |        |
| 1.                                   | Digital Logic and Computer Design M.MorrisMeno, Pearson Education                                                               |                        |              |        |
| 2.                                   | Digital Fundamentals Floyd and Jain, Pearson Education                                                                          |                        |              |        |
| 3.                                   | Digital Electronics Principles and integrated Circuits A.K.Maini, Wiley India                                                   |                        |              |        |
| 4.                                   | Modern Digital Electronics RP Jain                                                                                              |                        |              |        |
| 5.                                   | Fundamentals of digital circuits A Anand Kumar, PHI                                                                             |                        |              |        |
| URLs:                                |                                                                                                                                 |                        |              |        |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                 |                        |              |        |
| Lecture No.                          | Topic                                                                                                                           |                        |              |        |
| 1                                    | Introduction to digital systems, Difference between analog and digital systems Applications of digital systems                  |                        |              |        |
| 2                                    | Review of number systems Decimal number system, 9's and 10's complements, Arithmetic operations using 9's and 10's complements  |                        |              |        |

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| 3  | Binary, Octal and Hexa Decimal number systems, Conversion methods from one base to another base |
| 4  | complements- signed and unsigned Binary numbers Weighted and non-Weighted codes – ASCII code    |
| 5  | Binary codes: BCD Code, Gray Code, XS-3 code Applications of BCD, Gray and XS-3 codes           |
| 6  | BCD and XS-3 Addition and subtraction                                                           |
| 7  | Error detecting and Error correcting codes- hamming codes                                       |
| 8  | Examples on Error Detecting and Correcting codes                                                |
| 9  | Boolean postulates and laws–                                                                    |
| 10 | De-Morgan's Theorem- proof                                                                      |
| 11 | Logic Gates: AND, OR, NOT, NAND, NOR, Exclusive – OR and Exclusive – NOR.                       |
| 12 | Representation of a Boolean function (Truth table, Min term, Maxterm)                           |
| 13 | Implementations of Logic Functions using basic gates, NAND –NOR implementations                 |
| 14 | Minimization of Boolean expressions – Sum of Products (SOP) –Product of Sums (POS)-             |
| 15 | Canonical forms – Conversion from one canonical form to another                                 |
| 16 | Karnaugh map Minimization – 2,3&4 variables                                                     |
| 17 | Boolean simplification using Don't care terms                                                   |
| 18 | QuineMc'Clusky method of minimization                                                           |
| 19 | Introduction to combinational logic, Adder-Subtractor:Half adder, Full Adder                    |
| 20 | Half Subtractor, Full Subtractor                                                                |
| 21 | Types of adders: Serial, Parallel, Carry look ahead, BCD Adder                                  |
| 22 | Comparator, Multiplexer, Demultiplexer                                                          |
| 23 | Encoder, Decoder                                                                                |
| 24 | Code Converters: Binary to Grey, Grey to Binary                                                 |
| 25 | Design of Code Converters Using MUX and Decoder                                                 |
| 26 | Difference between Combinational and sequential circuits. Latches                               |
| 27 | Flip-Flops- SR Flip flop, JK Flip-flop                                                          |
| 28 | T flip-flop, D flip-flop                                                                        |
| 29 | Master slave Flip flops – Characteristic table and equation                                     |
| 30 | Application table– Edge triggering –Level Triggering                                            |
| 31 | Realization of one flip flop using other flip flops                                             |
| 32 | Asynchronous / Ripple counters – Synchronous counters                                           |
| 33 | Modulo – n counter                                                                              |
| 34 | Classification of sequential circuits                                                           |
| 35 | Analysis of clocked sequential circuits: State equation- State table                            |
| 36 | State diagram –State reduction and State assignment                                             |
| 37 | Register – shift registers- Universal shift register – Shift counters                           |
| 38 | Basic PLDs: ROM, PROM, Functions devices Realising using ROM, PLA, PAL                          |
| 39 | Realisation of Switching Functions using PLA                                                    |
| 40 | Realization of Switching Functions using PAL, FPGA, CPLDs                                       |

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| <b>Name of Program</b> | <b>B.TECH</b> | <b>Semester III</b> | <b>Year II</b> |
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| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | NETWORK ANALYSIS AND SYNTHESIS |  |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ECE 213                        |  |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Core                           |  |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| 1.                                | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |  |
| 2.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| 1                                 | Apply the knowledge of basic circuital law and simplify the network using reduction techniques                                                                                                                                                                                                                                                                                                                                                                               |                                |  |
| 2                                 | Analyze the circuit using Kirchhoff's law and Network simplification theorems                                                                                                                                                                                                                                                                                                                                                                                                |                                |  |
| 3                                 | Infer and evaluate transient response, Steady state response, network functions                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| 4                                 | Obtain the maximum power transfer to the load , and Analyze the series resonant and parallel resonant circuit                                                                                                                                                                                                                                                                                                                                                                |                                |  |
| 5                                 | Evaluate two-port network parameters , design attenuators and equalizers                                                                                                                                                                                                                                                                                                                                                                                                     |                                |  |
| 6                                 | Synthesize one port network using Foster and Cauer Forms                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |  |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
|                                   | Analysis: Review of kirchhoff's laws and circuit elements, Graph theory, Lattice and bridge T networks, coupled circuits, Network theorems, Differential equations: description of first and second order systems, Laplace transform and its applications in circuit analysis, Two port networks, properties of Network Functions.<br>Synthesis: Synthesis of passive networks, Hurwitz polynomial, PR funtions, realization of LC, RL, RC network by foster and cauer form. |                                |  |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| 1.                                | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |  |
| List of Reference Books:          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| 1.                                | Network Analysis by Van Vulkenburg                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |  |
| 2.                                | Circuit Theory (Analysis and Synthesis) A.Chakrabarti                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |  |
| 3.                                | Engineering Circuit Analysis William H. Hayt& Jack E. Kemmerly                                                                                                                                                                                                                                                                                                                                                                                                               |                                |  |
| 4.                                | Kuo F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India., 2008.                                                                                                                                                                                                                                                                                                                                                                                                    |                                |  |
| URLs:                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| 1.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |  |
| Lecture No.                       | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |  |
| 1                                 | Review of KCL and KVL                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |  |
| 2                                 | Circuit elements, Ideal sources - Dependent and Independent sources                                                                                                                                                                                                                                                                                                                                                                                                          |                                |  |
| 3                                 | Formation of matrix equations and analysis of complex circuits using mesh-current method                                                                                                                                                                                                                                                                                                                                                                                     |                                |  |

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| 4  | Formation of matrix equations and analysis of complex circuits using nodal voltage method             |
| 5  | Graph theory                                                                                          |
| 6  | Graph theory                                                                                          |
| 7  | Thevenin's Theorem, Norton's Theorem                                                                  |
| 8  | Thevenin's Theorem, Norton's Theorem                                                                  |
| 9  | Superposition theorem, Reciprocity theorem                                                            |
| 10 | Maximum power transfer theorem                                                                        |
| 11 | Compensation theorem                                                                                  |
| 12 | Tellegen's theorem & Millman's theorem                                                                |
| 13 | Faraday's laws of electromagnetic induction, Concept of self and mutual inductance                    |
| 14 | Dot convention, coefficient of coupling, analysis of series magnetic circuit                          |
| 15 | Analysis of parallel magnetic circuit, composite magnetic circuit and various problems                |
| 16 | First order differential equations and initial conditions                                             |
| 17 | First order differential equations and initial conditions                                             |
| 18 | Transient response of series RLC circuit                                                              |
| 19 | Transient response of series RL circuit                                                               |
| 20 | Transient response of series LC circuit                                                               |
| 21 | Second order differential equations                                                                   |
| 22 | First order differential equations and initial conditions                                             |
| 23 | Laplace transform                                                                                     |
| 24 | Laplace transform                                                                                     |
| 25 | Laplace transform                                                                                     |
| 26 | Network analysis- Network synthesis- Definitions, Network functions of one port and two port networks |
| 27 | Poles and Zeros of network functions                                                                  |
| 28 | Two port Parameters: $z$ , $y$ , $h$ , inverse- $h$ , ABCD parameters                                 |
| 29 | Causality and Stability analysis of network functions                                                 |
| 30 | Hurwitz polynomial                                                                                    |
| 31 | Positive Real Functions.                                                                              |
| 32 | Properties and Synthesis of LC driving point immittance function by Foster forms                      |
| 33 | Properties and Synthesis of driving point RC function by Foster forms                                 |
| 34 | Properties and Synthesis of driving point RC function by Foster forms                                 |
| 35 | Properties and Synthesis of driving point RL function by Foster forms                                 |
| 36 | Properties and Synthesis of driving point RL function by Foster forms                                 |
| 37 | Properties and Synthesis of LC driving point immittance function by Cauer forms                       |
| 38 | Properties and Synthesis of LC driving point immittance function by Cauer forms                       |
| 39 | Properties and Synthesis of driving point RC function by Cauer forms                                  |
| 40 | Properties and Synthesis of driving point RL function by Cauer forms                                  |

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| <b>Name of Program</b> | <b>B.TECH</b> | <b>Semester III</b> | <b>Year II</b> |
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|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>Name of Course</b>                    |                                                                                                                                                                                                                                                 | Mathematics of Signals & Systems |
| <b>Course Code</b>                       |                                                                                                                                                                                                                                                 | ECE 214                          |
| <b>Core / Elective / Other</b>           |                                                                                                                                                                                                                                                 | Core                             |
| <b>Prerequisite:</b>                     |                                                                                                                                                                                                                                                 |                                  |
| 1.                                       | Nil                                                                                                                                                                                                                                             |                                  |
| 2.                                       |                                                                                                                                                                                                                                                 |                                  |
| 3.                                       |                                                                                                                                                                                                                                                 |                                  |
| <b>Course Outcomes:</b>                  |                                                                                                                                                                                                                                                 |                                  |
| 1.                                       | Various classifications of both Continuous time and Discrete time Signals and Systems.                                                                                                                                                          |                                  |
| 2.                                       | Spectral analysis of Periodic and Aperiodic Signals using Fourier series.                                                                                                                                                                       |                                  |
| 3.                                       | Analysis and characterization of the CT system through Laplace transform and Fourier transform.                                                                                                                                                 |                                  |
| 4.                                       | Analysis and characterization of the DT system through classical method.                                                                                                                                                                        |                                  |
| 5.                                       | Analysis and characterization of the DT system through Z transform.                                                                                                                                                                             |                                  |
| <b>Description of Contents in brief:</b> |                                                                                                                                                                                                                                                 |                                  |
| 1.                                       | <u>Signals in Natural Domain, Introduction, Description of Signals, Basic Signals in Detail, Different operations on signals, Description of Systems, Properties of Systems, Classification of Systems</u>                                      |                                  |
| 2.                                       | <u>Continuous LTI Systems, Properties of LTI Systems, Differential and Difference Equations, Linear Shift Invariant Systems and their properties</u>                                                                                            |                                  |
| 3.                                       | <u>Signals in Frequency Domain, Fourier Series and its properties, Introduction to Transformations -Fourier Transform, and its Properties, Application of Fourier Transform in System analysis, Convolution, Correlation, Hilbert Transform</u> |                                  |
| 4.                                       | <u>Laplace Transform and its properties, Region of convergence, Analysis and characterization of LTI system using Laplace Transform</u>                                                                                                         |                                  |
| 5.                                       | <u>Sampling and Reconstruction of Band-Limited Signals, Discrete time Fourier transform and its Properties, Z Transform and its Properties, Region of Convergence, Application in Discrete system Analysis</u>                                  |                                  |
| <b>List of Text Books:</b>               |                                                                                                                                                                                                                                                 |                                  |
| 1.                                       | A. V. Oppenheim, A. S. Willsky and S. H. Nawab, Signals and Systems, 2nd Ed., Pearson Prentice Hall, 2008.                                                                                                                                      |                                  |
| 2.                                       | B.P. Lathi, “Principles of Linear Systems and Signals” Oxford , 2009.                                                                                                                                                                           |                                  |
| 3.                                       | S. Haykin and B. V. Veen, “Signals and Systems,” 2nd Ed., Wiley India, 2007.                                                                                                                                                                    |                                  |
| <b>List of Reference Books:</b>          |                                                                                                                                                                                                                                                 |                                  |

|              |                                                                                                                                               |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1.           | H. P. Hsu, "Signals and Systems – Schaum's Outline Series," McGraw Hill, 1995.                                                                |
| 2.           | John.G.Proakis and Manolakis " Digital Signal Processing-Principles ,Algorithms and Applications" , Pearson Education ,4th Edition 2009.      |
| 3.           | Rodger E Ziemer, William H. Tranter, D. Ronald Fannin, "Signals and Systems – continuous and Discrete", Pearson Education, 4th Edition, 2009. |
| <b>URLs:</b> |                                                                                                                                               |
| 1.           |                                                                                                                                               |
| 2.           |                                                                                                                                               |
| 3.           |                                                                                                                                               |

### Lecture Plan (about 40-50 Lectures):

| Lecture No. | Topic                                                                                       |
|-------------|---------------------------------------------------------------------------------------------|
| 1.          | Introduction to Signals and Systems                                                         |
| 2.          | Continuous time signals (CT signals), discrete time signals (DT signals)                    |
| 3.          | Periodic and non periodic signals                                                           |
| 4.          | Energy and power signals                                                                    |
| 5.          | Deterministic and random signals                                                            |
| 6.          | Basic operations on Signals: Time shifting and Time reversal                                |
| 7.          | Basic operations on Signals: Time Scaling                                                   |
| 8.          | Some important signals: Unit Step; Unit Ramp; Unit Impulse                                  |
| 9.          | Sampling and Derivatives of Impulse signals                                                 |
| 10.         | TUTORIAL                                                                                    |
| 11.         | Classification of Systems – Linear and Non-Linear, Time Variant and Time Invariant          |
| 12.         | Classification of Systems – Causal and Non-causal, Stable and Unstable, Static and Dynamic. |
| 13.         | TUTORIAL                                                                                    |
| 14.         | <u>Continuous LTI Systems</u>                                                               |
| 15.         | <u>Continuous LTI Systems</u> Properties                                                    |
| 16.         | Convolution                                                                                 |
| 17.         | Correlation                                                                                 |
| 18.         | <u>Linear Shift Invariant Systems</u>                                                       |
| 19.         | <u>Linear Shift Invariant Systems</u> Properties                                            |
| 20.         | TUTORIAL                                                                                    |
| 21.         | Fourier series analysis                                                                     |
| 22.         | Properties of Fourier Series Analysis                                                       |
| 23.         | Problems on Fourier series                                                                  |
| 24.         | TUTORIAL                                                                                    |
| 25.         | Fourier Transform analysis                                                                  |
| 26.         | Properties of Fourier Transform                                                             |
| 27.         | Problems on Fourier Transform                                                               |
| 28.         | Application of Fourier Transform in system analysis                                         |
| 29.         | TUTORIAL                                                                                    |

|     |                                                     |
|-----|-----------------------------------------------------|
| 30. | Laplace Transform                                   |
| 31. | Properties of Laplace Transform                     |
| 32. | Problems on Laplace Transform                       |
| 33. | Problems on Inverse Laplace Transform               |
| 34. | Application of Laplace Transform in system analysis |
| 35. | TUTORIAL                                            |
| 36. | Analysis of discrete time signals: DTFS,DTFT        |
| 37. | Properties of DTFT and problems                     |
| 38. | Z-transform and ROC                                 |
| 39. | Properties of Z-transform and problems              |
| 40. | TUTORIAL                                            |

## **FOURTH SEMESTER**

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |         |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------|
| Name of Program                   | B.TECH                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Semester IV | Year II |
| Name of Course                    | Fundamentals of Entrepreneurship                                                                                                                                                                                                                                                                                                                                                                                                                               |             |         |
| Course Code                       | HUM 251                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |         |
| Core / Elective / Other           | Core                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |         |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |         |
| 1.                                | Organizational theories and Motivation for Entrepreneurship enthusiastic for systematic approach to handle the materialistic and non-materialistic motivation.                                                                                                                                                                                                                                                                                                 |             |         |
| 2.                                | Business Plan and fundamentals of Entrepreneur Development for engineering graduates to survive in this competitive world.                                                                                                                                                                                                                                                                                                                                     |             |         |
| 3.                                | A hybrid approach for technocrats to handle the multifunctional technicalities in case of industrial laws and New social security and pension rules.                                                                                                                                                                                                                                                                                                           |             |         |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |         |
| 1.                                | Course will inculcate administrative skills for Engineers to handle the all the matters related to personnel and their dimensions.                                                                                                                                                                                                                                                                                                                             |             |         |
| 2.                                | Engineering students will be in position to take appropriate decision to understand the industrial Laws and application of administrative principles for smooth functioning of Industry and a fresh idea to setup new business.                                                                                                                                                                                                                                |             |         |
| 3.                                | Boost up the engineers to develop Business ideas to become successful entrepreneurs to setup new operational business units to address the need of society.                                                                                                                                                                                                                                                                                                    |             |         |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |         |
| 1.                                | Meaning, nature and scope of Personnel Administration in India, functions and significance of Personnel Administration, Recruitment, Training, Promotion and Disciplinary Action, Classification of Services, Generalists and Specialists, Development of Public Services in India, Bureaucracy and Modern Democratic System, Performance Appraisal                                                                                                            |             |         |
| 2.                                | Organizational Development Theories, Fredric Winslow Taylor, Marry Parker Follett, Elton Mayo, Max Weber, Henry Fayol, Power, Accountability, Responsibility, Control, Transparency and Conflict Resolutions                                                                                                                                                                                                                                                   |             |         |
| 3.                                | Meaning and importance of Entrepreneurship, Evolution of Entrepreneurship, Factors influencing Entrepreneurship: Social factors, psychological factors, economical factors and environmental factors. Characteristics of an Entrepreneur, Types of Entrepreneur: type of business, use of technology, motivation. New Generation of entrepreneurship: social entrepreneurship, tourism entrepreneurship, women entrepreneurship. Barriers to Entrepreneurship. |             |         |
| 4.                                | Entrepreneurial motivation: Relevance of Motivation, Maslow's Theory, Herzberg's Theory, Douglas McGregor, Ethics, Corruption and Anti-Corruption Machinery in country                                                                                                                                                                                                                                                                                         |             |         |
| 5.                                | Factory Act 1948, Provident Fund Act 1952, Compensation Act 1919, Special Economic Zone (SEZ), National Small Industries, Quality Standard with Special reference to (ISO), Small Industries Development Bank of India (ISDBI), New Pension Scheme 2004 Act.                                                                                                                                                                                                   |             |         |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |         |



|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |             |         |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------------|---------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | B.Tech                    | Semester IV | Year II |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Digital Signal Processing |             |         |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ECE 221                   |             |         |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Core                      |             |         |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |             |         |
| 1.                                | Signals and linear systems theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |             |         |
| 2.                                | Laplace and Fourier transform                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                           |             |         |
| 3.                                | Electric Circuit Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |             |         |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |             |         |
| 1.                                | To acquire the knowledge about discrete-time sequences, frequency analysis and LTI system.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                           |             |         |
| 2.                                | To acquire the knowledge of DTFT, DFT and their corresponding properties.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                           |             |         |
| 3.                                | To understand the significance of z-transform in discrete systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                           |             |         |
| 4.                                | Ability to design different types of digital filters both FIR and IIR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                           |             |         |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |             |         |
| 1.                                | Discrete Time Fourier Transform(DTFT): Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain.                                                                                                                                                                                                                                   |                           |             |         |
| 2.                                | Z- Transforms: Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Parseval's relation, inverse Z-transform by contour integration, power series & partial-fraction expansions with examples and exercises.                                                                                 |                           |             |         |
| 3.                                | Discrete Fourier Transform: Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circular convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises. |                           |             |         |
| 4.                                | Fast Fourier Transforms: Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.                                                                                                                                                                                                                                                                                                      |                           |             |         |
| 5.                                | Filter design: Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows.                                                                                                                                                                                                                                                                                    |                           |             |         |

|                                             | Effect of quantization, Applications of DSP                                                               |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>List of Text Books:</b>                  |                                                                                                           |
| 1.                                          | Discrete-Time Signal Processing by A. V. Oppenheim and R. W. Schafer.                                     |
| 2.                                          | Digital Signal Processing: Principles, Algorithms, and Applications by J. G. Proakis and D. G. Manolakis. |
| 3.                                          | Digital Signal Processing by Schaums Series, TMH.                                                         |
| <b>List of Reference Books:</b>             |                                                                                                           |
| 1.                                          | Theory and Application of Digital Signal Processing by Rabiner and Gold.                                  |
| 2.                                          | Introduction to digital signal processing, Johnny R. Johnson.                                             |
| 3.                                          | Digital Signal Processing: S. Mitra                                                                       |
| <b>URLs:</b>                                |                                                                                                           |
| 1.                                          | <a href="https://nptel.ac.in/courses/117102060/">https://nptel.ac.in/courses/117102060/</a>               |
| 2.                                          | <a href="https://nptel.ac.in/courses/108106151/">https://nptel.ac.in/courses/108106151/</a>               |
| 3.                                          | <a href="https://nptel.ac.in/courses/108105055/">https://nptel.ac.in/courses/108105055/</a>               |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                           |
| Lecture No.                                 | Topic                                                                                                     |
| 1.                                          | Introduction of Analog and Digital Signal Processing                                                      |
| 2.                                          | Representation and Analysis of discrete system                                                            |
| 3.                                          | discrete time signal & systems                                                                            |
| 4.                                          | LTI systems and their properties, Linear Convolution                                                      |
| 5.                                          | linear constant-coefficient difference equations                                                          |
| 6.                                          | Representation of recursive and non recursive system.                                                     |
| 7.                                          | Tutorial                                                                                                  |
| 8.                                          | Z Transform                                                                                               |
| 9.                                          | One sided and Two sided Z Transform                                                                       |
| 10.                                         | Properties of Z Transform                                                                                 |
| 11.                                         | Properties of Z Transform                                                                                 |
| 12.                                         | properties of ROC for Z-transform                                                                         |
| 13.                                         | Inverse Z Transform                                                                                       |
| 14.                                         | Realizable Systems, Stability & Causality                                                                 |
| 15.                                         | Inverse System, Pole zero cancellation in system function                                                 |
| 16.                                         | Tutorial                                                                                                  |
| 17.                                         | Introduction to Discrete Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT)               |
| 18.                                         | Relation between DTFT and DFT,                                                                            |
| 19.                                         | Properties of DFT                                                                                         |
| 20.                                         | Linear and Circular Convolution                                                                           |
| 21.                                         | Fast Fourier Transform (FFT)                                                                              |
| 22.                                         | FFT Computation using Decimation in time – Radix 2 FFT algorithm                                          |
| 23.                                         | Tutorial                                                                                                  |
| 24.                                         | FFT Computation using Decimation in frequency – Radix 2 FFT algorithm                                     |
| 25.                                         | Tutorial                                                                                                  |
| 26.                                         | Composite Radix FFT                                                                                       |

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|-----|----------------------------------------------------------------------------------------------------------------|
| 27. | Design of analog Butterworth Filter                                                                            |
| 28. | Design of analog Chebyshev Filter                                                                              |
| 29. | Frequency transformation in analog domain<br>Design of IIR digital filters using impulse invariance technique, |
| 30. | Design of IIR digital filters using bilinear transformation                                                    |
| 31. | Tutorial                                                                                                       |
| 32. | Realization using Direct form I                                                                                |
| 33. | Realization using Direct form II                                                                               |
| 34. | Realization using cascade forms                                                                                |
| 35. | Realization using Parallel forms                                                                               |
| 36. | Realization of FIR Filter                                                                                      |
| 37. | Tutorial                                                                                                       |
| 38. | Linear Phase FIR filters, Problems on Linear phase FIR filter, Gibbs phenomenon                                |
| 39. | Design of FIR filter using windowing techniques – Hamming, Hanning and Blackmann windows                       |
| 40. | Design of FIR filter using windowing techniques Blackmann windows                                              |
| 41. | Design of FIR filter using Frequency Sampling method                                                           |
| 42. | Tutorial                                                                                                       |
| 43. | Application of DSP in Communication                                                                            |
| 44. | Application of DSP in Biomedical                                                                               |
| 45. | Application of DSP in Image Processing                                                                         |
| 46. | DCT and Wavelet Transform                                                                                      |

| Name of Program                                                          | B.TECH                                                                                                   | Semester IV | Year II |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-------------|---------|
| Name of Course                                                           | LINEAR INTEGRATED CIRCUITS                                                                               |             |         |
| Course Code                                                              | ECE 222                                                                                                  |             |         |
| Core / Elective / Other                                                  | Core                                                                                                     |             |         |
| Prerequisite:                                                            |                                                                                                          |             |         |
| 1.                                                                       | Basic Network Analysis.                                                                                  |             |         |
| 2.                                                                       |                                                                                                          |             |         |
| 3.                                                                       |                                                                                                          |             |         |
| Course Outcomes: After completion of the course student will be able to: |                                                                                                          |             |         |
| 1.                                                                       | Describe and discuss importance of feedback in amplification.                                            |             |         |
| 2.                                                                       | Differential amplifier, configuration and applications .                                                 |             |         |
| 3.                                                                       | Basic building block of OP-AMP ,OPAMPS parameters, ideal and non ideal opamps amplifiers and comparison. |             |         |
| 4.                                                                       | Design, Analyze and Categorized different linear circuits and applications using opamps .                |             |         |
| 5.                                                                       | Explain & Discuss Understating of analog filters ,Introduction to ADCs and DACS and designing .          |             |         |
| 6.                                                                       | Simulate and verify the functionality of BJT, JFET & MOSFET and opamps circuits                          |             |         |

|                                             |                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | using PSpice.                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Description of Contents in brief:</b>    |                                                                                                                                                                                                                                                                                                                                                                                        |
| 1.                                          | Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short ; Analysis of simple operational amplifier circuits; Frequency response of amplifiers, Bode plots.                                                                                                                         |
| 2.                                          | Feedback: Feedback topologies and analysis for discrete transistor amplifiers; stability of feedback circuits using Barkhausen criteria.                                                                                                                                                                                                                                               |
| 3.                                          | Linear application operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters.                                                                                                                                                                                                                                                      |
| 4.                                          | Non-linear applications of operational amplifiers: Comparators, clippers and clampers; Linearization amplifiers; Precision rectifiers; Logarithmic amplifiers, multifunction circuits and true rms convertors.                                                                                                                                                                         |
| 5.                                          | Waveform Generation: sinusoidal feedback oscillators; Relaxation oscillators, square triangle oscillators. Real operational amplifiers: Current sources and active loads, difference, intermediate and output stages including Miller capacitors for frequency computation; Operational amplifier parameters; Effects of real operational amplifier parameters on circuit performance. |
| 6.                                          | Analog and Digital interface circuits: A/D, D/A Converters, S/H circuits and multiplexers.                                                                                                                                                                                                                                                                                             |
| <b>List of Text Books:</b>                  |                                                                                                                                                                                                                                                                                                                                                                                        |
| 1.                                          | Microelectronic Circuits: Theory and Applications, Adel S. <a href="#">Sedra</a> , Kenneth C. <a href="#">Smith</a> , ArunN. <a href="#">Chandorkar</a> .                                                                                                                                                                                                                              |
| 2.                                          | Microelectronics Circuits Analysis and Design, Muhammad H. Rashid                                                                                                                                                                                                                                                                                                                      |
| 3.                                          |                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>List of Reference Books:</b>             |                                                                                                                                                                                                                                                                                                                                                                                        |
| 1.                                          | Introduction to Operational J.V. Wait, L.P. Huelsman and GA Korn, Amplifier theory and applications 2nd edition, McGraw Hill, New York, 1992.                                                                                                                                                                                                                                          |
| 2.                                          | Microelectronics J. Millman and A. Grabel, 2nd edition, McGraw Hill, 1988.                                                                                                                                                                                                                                                                                                             |
| 3.                                          | The Art of Electronic P. Horowitz and W. Hill, 2nd edition, Cambridge University Press, 1989.                                                                                                                                                                                                                                                                                          |
| 4.                                          | Microelectronic Circuits A.S. Sedra and K.C. Smith Saunder's College Publishing, 1991.                                                                                                                                                                                                                                                                                                 |
| <b>URLs:</b>                                |                                                                                                                                                                                                                                                                                                                                                                                        |
| 1.                                          | <a href="http://class.ece.iastate.edu/ee435/">http://class.ece.iastate.edu/ee435/</a>                                                                                                                                                                                                                                                                                                  |
| 2.                                          | <a href="https://people.eecs.berkeley.edu/~pister/140sp20/">https://people.eecs.berkeley.edu/~pister/140sp20/</a>                                                                                                                                                                                                                                                                      |
| 3.                                          | <a href="http://class.ece.iastate.edu/ee508/">http://class.ece.iastate.edu/ee508/</a>                                                                                                                                                                                                                                                                                                  |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 1.                                          | Basic introduction about the subject.                                                                                                                                                                                                                                                                                                                                                  |
| 2.                                          | Introduction to operational amplifiers.                                                                                                                                                                                                                                                                                                                                                |
| 3.                                          | The difference amplifier.                                                                                                                                                                                                                                                                                                                                                              |
| 4.                                          | The ideal operational amplifier models.                                                                                                                                                                                                                                                                                                                                                |
| 5.                                          | Concept of negative feedback.                                                                                                                                                                                                                                                                                                                                                          |
| 6.                                          | Concept of virtual short.                                                                                                                                                                                                                                                                                                                                                              |
| 7.                                          | Analysis of simple operational amplifier circuits.                                                                                                                                                                                                                                                                                                                                     |
| 8.                                          | Contd. Analysis of simple operational amplifier circuits.                                                                                                                                                                                                                                                                                                                              |

|            |                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------|
| <b>9.</b>  | Frequency response of amplifiers.                                                                          |
| <b>10.</b> | Bode plots.                                                                                                |
| <b>11.</b> | Contd. Bode plots.                                                                                         |
| <b>12.</b> | Feedback.                                                                                                  |
| <b>13.</b> | Feedback topologies.                                                                                       |
| <b>14.</b> | Analysis for discrete transistor amplifiers.                                                               |
| <b>15.</b> | Stability of feedback circuits using Barkhausen criteria.                                                  |
| <b>16.</b> | Linear application operational amplifiers.                                                                 |
| <b>17.</b> | Instrumentation amplifiers                                                                                 |
| <b>18.</b> | Isolation amplifiers.                                                                                      |
| <b>19.</b> | Linear application operational amplifiers.                                                                 |
| <b>20.</b> | Current sources.                                                                                           |
| <b>21.</b> | voltage sources.                                                                                           |
| <b>22.</b> | Active filters.                                                                                            |
| <b>23.</b> | Non-linear applications of operational amplifiers                                                          |
| <b>24.</b> | Contd. Non-linear applications of operational amplifiers.                                                  |
| <b>25.</b> | Comparators.                                                                                               |
| <b>26.</b> | Clippers.                                                                                                  |
| <b>27.</b> | Clampers.                                                                                                  |
| <b>28.</b> | Linearization amplifiers.                                                                                  |
| <b>29.</b> | Precision rectifiers.                                                                                      |
| <b>30.</b> | Logarithmic amplifiers.                                                                                    |
| <b>31.</b> | Multifunction circuits and true rms convertors.                                                            |
| <b>32.</b> | Waveform Generation: sinusoidal feedback oscillators.                                                      |
| <b>33.</b> | Relaxation oscillators.                                                                                    |
| <b>34.</b> | Square triangle oscillators.                                                                               |
| <b>35.</b> | Real operational amplifiers: Current sources and active loads, difference.                                 |
| <b>36.</b> | Intermediate and output stages including Miller capacitors for frequency computation.                      |
| <b>37.</b> | Operational amplifier parameters; Effects of real operational amplifier parameters on circuit performance. |
| <b>38.</b> | Analog and Digital interface circuits: A/D Converters.                                                     |
| <b>39.</b> | D/A Converters.                                                                                            |
| <b>40.</b> | S/H circuits and multiplexers.                                                                             |

|                                   |                                                                                                            |             |         |
|-----------------------------------|------------------------------------------------------------------------------------------------------------|-------------|---------|
| Name of Program                   | B.TECH                                                                                                     | Semester IV | Year II |
| Name of Course                    | Microprocessors and Microcontrollers                                                                       |             |         |
| Course Code                       | ECE 223                                                                                                    |             |         |
| Core / Elective / Other           | Core                                                                                                       |             |         |
| Prerequisite:                     |                                                                                                            |             |         |
| 1.                                | Digital Electronics                                                                                        |             |         |
| 2.                                |                                                                                                            |             |         |
| 3.                                |                                                                                                            |             |         |
| Course Outcomes:                  |                                                                                                            |             |         |
| 1.                                | Recall and apply a basic concept of digital fundamentals to Microprocessor based personal computer system. |             |         |
| 2.                                | Identify a detailed s/w & h/w structure of the Microprocessor.                                             |             |         |
| 3.                                | Illustrate how the different peripherals (8255, 8253 etc.) Are interfaced with microprocessor.             |             |         |
| 4.                                | Distinguish and analyze the properties of Microprocessors & Microcontrollers.                              |             |         |
| 5.                                | Analyze the data transfer information through serial & parallel ports.                                     |             |         |
| Description of Contents in brief: |                                                                                                            |             |         |
| 1.                                | Evolution of Microprocessor, Microprocessor 8085 - internal architecture, Memory                           |             |         |

|    |                                                                                                                                                                                               |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | Mapping, Instruction set and assembly language programming.                                                                                                                                   |
| 2. | Introduction to 8086 microprocessor - internal architecture, pin description, memory segmentation, addressing modes, instruction set and assembly language programming.                       |
| 3. | Basic Interfacing devices: Memory interfacing, 8255, 8253, 8259, 8257, 8251, Interfacing A/D and D/A converters, Case studies of microprocessor based systems.                                |
| 4. | Salient features of advanced microprocessors: 80286,386,486,Pentium, Concept of CISC and RISC processors, Introduction to ARM processor.                                                      |
| 5. | Introduction to 8051 microcontrollers, its architecture, pin description, I/O configuration, interrupts, addressing modes, an overview of 8051 instruction set, Microcontroller applications. |

#### **List of Text Books:**

|    |                                                                                                                           |
|----|---------------------------------------------------------------------------------------------------------------------------|
| 1. | R. S. Gaonkar, Microprocessor Architecture Programming and Applications, 2 nd Ed, New Age International Publishers, 1995. |
| 2. | Douglas V. Hall, SSSP Rao, Microprocessors and Interfacing, Third Edition, McGrawHill Education.                          |
| 3. | Kenneth J Ayala, The 8051 Microcontroller , (3/e), Thomson Delmar Learning, 2004.                                         |

#### **List of Reference Books:**

|    |                                                                                                                   |
|----|-------------------------------------------------------------------------------------------------------------------|
| 1. | M.A. Mazidi& J.C. Mazidi Microcontroller and Embedded systems using Assembly & C. (2/e), Pearson Education, 2007. |
| 2. | J.L. Antonakos, An Introduction to the Intel Family of Microprocessors, Pearson, 1999.                            |
| 3. | Barry B. Brey, The Intel Microprocessors, (7/e), Eastern Economy Edition , 2006.                                  |

#### **URLs:**

|    |  |
|----|--|
| 1. |  |
| 2. |  |
| 3. |  |

#### **Lecture Plan (about 40-50 Lectures):**

| <b>Lecture No.</b> | <b>Topic</b>                                                                                         |
|--------------------|------------------------------------------------------------------------------------------------------|
| 1.                 | Evolution of Microprocessor                                                                          |
| 2.                 | Typical organization of a microcomputer system and functions of its various blocks                   |
| 3.                 | Architecture of a Microprocessor (With reference to 8085 microprocessor)                             |
| 4.                 | Concept of Bus, bus organization of 8085,Functional block diagram of 8085 and function of each block |
| 5.                 | Register structure of 8085                                                                           |
| 6.                 | Pin details of 8085 and related signals                                                              |
| 7.                 | Concept of memory mapping,                                                                           |
| 8.                 | Instruction Timing and Cycles ( Basic Introduction)                                                  |
| 9.                 | Brief idea of machine and assembly languages, Machines and Mnemonic codes                            |
| 10.                | Instruction format and Addressing modes                                                              |
| 11.                | Instruction set, Data transfer group, Arithmetic Group, Logic Group                                  |

|     |                                                                                         |
|-----|-----------------------------------------------------------------------------------------|
| 12. | Stack, I/O and Machine Control Group                                                    |
| 13. | Programming exercises in assembly language (with the help of examples)                  |
| 14. | Various hardware and software interrupts of 8085                                        |
| 15. | 8086 Microprocessor - Architecture and signals, Memory Segmentation                     |
| 16. | Register structure of 8086                                                              |
| 17. | Pin details of 8086 and related signals                                                 |
| 18. | Minimum and maximum mode of operation                                                   |
| 19. | Comparison of 8086 and 8088                                                             |
| 20. | 8086 Addressing Modes                                                                   |
| 21. | 8086 Instruction set, Data transfer group                                               |
| 22. | Arithmetic Group, Logical Group                                                         |
| 23. | String Instructions                                                                     |
| 24. | Branching and Machine Control Operations                                                |
| 25. | Assembly Language Programming                                                           |
| 26. | Assembly Language Programming                                                           |
| 27. | Timing Diagram, Bus Timing                                                              |
| 28. | Interfacing Memory with 8086                                                            |
| 29. | General purpose interfacing devices                                                     |
| 30. | PPI 8255 - Detailed study, Architecture, Control word format and modes of operation     |
| 31. | USART 8251- Detailed study, Architecture, Control word format and modes of operation    |
| 32. | DMA 8257- Detailed study, Architecture, Control word format and modes of operation      |
| 33. | PIC 8259- Detailed study, Architecture, Control word format and modes of operation      |
| 34. | TIMER 8253/54- Detailed study, Architecture, Control word format and modes of operation |
| 35. | Salient features of advanced microprocessors: 80286,386,486, Pentium                    |
| 36. | CISC and RISC processors                                                                |
| 37. | Introduction to ARM processor                                                           |
| 38. | Microcontrollers - Types of Microcontrollers, Criteria for selecting a microcontroller  |
| 39. | Microcontroller – 8051, Architecture,                                                   |
| 40. | Microcontroller – 8051, Register Organization, Memory and I/O addressing                |
| 41. | 8051 Addressing Modes                                                                   |
| 42. | Different types of instructions and Instruction Set                                     |
| 43. | Simple Programs                                                                         |

|                                   |                                                                                                                                                                                                                                         |                                               |             |         |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-------------|---------|
| Name of Program                   |                                                                                                                                                                                                                                         | B.Tech                                        | Semester IV | Year II |
| Name of Course                    |                                                                                                                                                                                                                                         | Electromagnetic Fields and Transmission Lines |             |         |
| Course Code                       |                                                                                                                                                                                                                                         | ECE 224                                       |             |         |
| Core / Elective / Other           |                                                                                                                                                                                                                                         | Core                                          |             |         |
| Prerequisite:                     |                                                                                                                                                                                                                                         |                                               |             |         |
| 1.                                | Vector Algebra                                                                                                                                                                                                                          |                                               |             |         |
| 2.                                | Matrix operations                                                                                                                                                                                                                       |                                               |             |         |
| 3.                                | Differentiation and Integration                                                                                                                                                                                                         |                                               |             |         |
| Course Outcomes:                  |                                                                                                                                                                                                                                         |                                               |             |         |
| 1.                                | Understanding applications of Vector calculus and matrix operations in EM fields                                                                                                                                                        |                                               |             |         |
| 2.                                | To understand basics of the three orthogonal coordinate systems namely Cartesian, Cylindrical and Spherical and learning transformation of a point and a vector from one coordinate system to another coordinate system.                |                                               |             |         |
| 3.                                | To learn vector calculus such as Gradient, Divergence, Curl and Laplacian.                                                                                                                                                              |                                               |             |         |
| 4.                                | understanding of basics of Electrostatics and Magnetostatics                                                                                                                                                                            |                                               |             |         |
| 5.                                | Capable to analyze and understand EM wave propagation through various types of mediums and boundary conditions.                                                                                                                         |                                               |             |         |
| Description of Contents in brief: |                                                                                                                                                                                                                                         |                                               |             |         |
| 1.                                | Review of vector algebra, Cartesian, Cylindrical and Spherical Coordinate Systems (CS) and transformation of a point and a vector of one CS to another CS. Del operator, Gradient, Divergence, Curl, Laplacian and Poission's equation. |                                               |             |         |
| 2.                                | Electrostatic field due to uniform charge distribution over line, surface and volume, Gauss Law and applications.                                                                                                                       |                                               |             |         |

|    |                                                                                                                                                                                                                                                                                                                       |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. | Magnetostatic field Ampere's law and applications. Maxwell's equations for static and time varying field, boundary conditions for conductor and dielectric                                                                                                                                                            |
| 4. | Wave equations for free space, uniform plane waves, linear, elliptical and circular polarization, wave equations for conducting medium, wave propagation in conductors and dielectric, depth of penetration, reflection and refraction of plane waves by conductor and dielectric, Poynting vector and flow of power, |
| 5. | Introduction and analysis of Transmission Line, Physical Interpretation of Voltage & Current Solution, Impedance Characteristics of Loss less Transmission Line.                                                                                                                                                      |

#### List of Text Books:

|    |                                                                |
|----|----------------------------------------------------------------|
| 1. | Elements of Electromagnetics Mathew N.O. Sadiku                |
| 2. | Introduction to Electrodynamics David J. Griffiths             |
| 3. | Network and Transmission Lines G.K.Mithal, Khanna publications |

#### List of Reference Books:

|    |                                                                                                               |
|----|---------------------------------------------------------------------------------------------------------------|
| 1. | Engineering Electromagnetics W.H. Hayt                                                                        |
| 2. | Engineering Electromagnetics, McGraw Hill John D Kraus Engineering Electromagnetics, McGraw Hill John D Kraus |
| 3. | Network and Transmission Lines J.D. Ryder, prentice hall of India                                             |

#### URLs:

|    |                                                                                             |
|----|---------------------------------------------------------------------------------------------|
| 1. | <a href="https://nptel.ac.in/courses/117101056/">https://nptel.ac.in/courses/117101056/</a> |
| 2. | <a href="https://swayam.gov.in/nd1_noc20_ee04">https://swayam.gov.in/nd1_noc20_ee04</a>     |

#### Lecture Plan (about 40-50 Lectures):

| Lecture No. | Topic                                                            |
|-------------|------------------------------------------------------------------|
| 1.          | Review of vector algebra                                         |
| 2.          | Cartesian, Cylindrical and Spherical Coordinate Systems (CS)     |
| 3.          | Transformation of a point and a vector of one CS to another CS   |
| 4.          | Del operator, Gradient,                                          |
| 5.          | Divergence, Divergence Theorem                                   |
| 6.          | Curl, Stoke's Theorem                                            |
| 7.          | Laplacian and Poisson's equation                                 |
| 8.          | Electrostatic field due to uniform charge distribution over line |
| 9.          | Electrostatic field due to uniform                               |
| 10.         | Electrostatic field due to uniform surface charge                |
| 11.         | Electrostatic field due to uniform Volume charge distribution    |
| 12.         | Gauss Law and applications.                                      |
| 13.         | Gauss Law and applications Continued                             |
| 14.         | Magnetostatic field Ampere's law and applications                |
| 15.         | Magnetostatic field Ampere's law and applications continued      |
| 16.         | Maxwell's equations for static and time varying field            |
| 17.         | Maxwell's equations in frequency domain                          |
| 18.         | Boundary conditions for conductor and dielectric                 |
| 19.         | Boundary conditions for dielectric and another dielectric        |
| 20.         | Boundary conditions for dielectric and Air                       |
| 21.         | Wave equations for free space                                    |

|                                          |                                                                                                                                                                                                                                                                           |                                            |                    |                |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|--------------------|----------------|
| 22.                                      | Wave equations for free spacecontinued                                                                                                                                                                                                                                    |                                            |                    |                |
| 23.                                      | Uniform plane waves, linear                                                                                                                                                                                                                                               |                                            |                    |                |
| 24.                                      | Elliptical and circular polarization                                                                                                                                                                                                                                      |                                            |                    |                |
| 25.                                      | Wave equations for conducting medium                                                                                                                                                                                                                                      |                                            |                    |                |
| 26.                                      | Wave propagation in conductors                                                                                                                                                                                                                                            |                                            |                    |                |
| 27.                                      | Wave propagation dielectric                                                                                                                                                                                                                                               |                                            |                    |                |
| 28.                                      | Wave propagation from conductor to dielectric and vice versa                                                                                                                                                                                                              |                                            |                    |                |
| 29.                                      | Depth of penetration                                                                                                                                                                                                                                                      |                                            |                    |                |
| 30.                                      | Standing waves and Standing wave ratio                                                                                                                                                                                                                                    |                                            |                    |                |
| 31.                                      | Standing waves and Standing wave ratiocontinued                                                                                                                                                                                                                           |                                            |                    |                |
| 32.                                      | Reflection and refraction of plane waves                                                                                                                                                                                                                                  |                                            |                    |                |
| 33.                                      | Reflection and refraction of plane wavescontinued                                                                                                                                                                                                                         |                                            |                    |                |
| 34.                                      | Poynting vector and flow of power                                                                                                                                                                                                                                         |                                            |                    |                |
| 35.                                      | Poynting vector and flow of power continued                                                                                                                                                                                                                               |                                            |                    |                |
| 36.                                      | Introduction and analysis of Transmission Line                                                                                                                                                                                                                            |                                            |                    |                |
| 37.                                      | Introduction and analysis of Transmission Line continued                                                                                                                                                                                                                  |                                            |                    |                |
| 38.                                      | Physical Interpretation of Voltage & Current Solution                                                                                                                                                                                                                     |                                            |                    |                |
| 39.                                      | Physical Interpretation of Voltage & Current Solutioncontinued                                                                                                                                                                                                            |                                            |                    |                |
| 40.                                      | Impedance Characteristics of Loss less Transmission Line                                                                                                                                                                                                                  |                                            |                    |                |
| <b>Name of Program</b>                   |                                                                                                                                                                                                                                                                           | B.Tech.                                    | <b>Semester IV</b> | <b>Year II</b> |
| <b>Name of Course</b>                    |                                                                                                                                                                                                                                                                           | Electronic Instrumentation and Measurement |                    |                |
| <b>Course Code</b>                       |                                                                                                                                                                                                                                                                           | ECE 225                                    |                    |                |
| <b>Core / Elective / Other</b>           |                                                                                                                                                                                                                                                                           | Core                                       |                    |                |
| <b>Prerequisite:</b>                     |                                                                                                                                                                                                                                                                           |                                            |                    |                |
| 1.                                       | Signal and system                                                                                                                                                                                                                                                         |                                            |                    |                |
| 2.                                       | Network Analysis                                                                                                                                                                                                                                                          |                                            |                    |                |
| <b>Course Outcomes:</b>                  |                                                                                                                                                                                                                                                                           |                                            |                    |                |
| CO-1                                     | Understand the fundamental concepts of Measurement and instrumentation.                                                                                                                                                                                                   |                                            |                    |                |
| CO-2                                     | Understand the measurement of electrical quantities and non-electrical quantities.                                                                                                                                                                                        |                                            |                    |                |
| CO-3                                     | Understand the design and working of Signal generators, signal analyzers and display devices.                                                                                                                                                                             |                                            |                    |                |
| CO-4                                     | The student will be able to understand the working principle of various instruments used in the labs.                                                                                                                                                                     |                                            |                    |                |
| CO-5                                     | The student will able to understand the working of various transducers and their application.                                                                                                                                                                             |                                            |                    |                |
| <b>Description of Contents in brief:</b> |                                                                                                                                                                                                                                                                           |                                            |                    |                |
| 1.                                       | Block schematics of measuring systems, performance characteristics, Static characteristics, DC voltmetersand ammeter, AC voltmeters and current meters, ohmmeters, multimeters, meter protection,extension of range, digital voltmeters.                                  |                                            |                    |                |
| 2.                                       | Oscilloscopes: CRO Structure, applications, specifications, working.Special purpose oscilloscopes: Dual trace, dual beamCROs, sampling oscilloscopes, storage oscilloscopes, digital storage CROs, Lissajous figures,frequency measurement, phase measurement, CRO probes |                                            |                    |                |

|    |                                                                                                                                                                                                                                                                                                                                           |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. | Measurements using bridges: Wheat stone bridge, Kelvin bridge, AC bridges, Maxwell, Hay, Schering, Wien, Anderson bridges, Wagner & ground connection.                                                                                                                                                                                    |
| 4. | Transducers: Classification, strain gauges, force and displacement, transducers, resistance thermometers, hotwire anemometers, LVDT, thermocouples, synchros; Piezoelectric transducers, variable capacitance transducers.                                                                                                                |
| 5. | Signal Generators: AF and RF signal generators, sine and square wave generators, function generators arbitrary waveform generator, sweep frequency generators, video signal generators, and specifications. Signal Analyzers: AF, HF wave analyzers, heterodyne wave analyzers, harmonic distortion, spectrum analyzers, power analyzers. |

#### List of Text Books:

|    |                                                                |
|----|----------------------------------------------------------------|
| 1. | Electronics Instrumentation & Measurement System A.K. Shawney  |
| 2. | Electronics Measurement and Instrumentation Kalsi, PHI         |
| 3. | Electronics Measurement and Instrumentation, W.D. Cooper, PHI. |

#### List of Reference Books:

|    |                                                                                                                      |
|----|----------------------------------------------------------------------------------------------------------------------|
| 1. | David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press, 1 <sup>st</sup> Edition, 2007 |
| 2. | Doebelin, E.O., Measurement systems, McGraw Hill, Fourth edition                                                     |

#### URLs:

|    |                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------|
| 1. | <a href="https://nptel.ac.in/courses/108/105/108105153/">https://nptel.ac.in/courses/108/105/108105153/</a> |
|----|-------------------------------------------------------------------------------------------------------------|

#### Lecture Plan (about 40-50 Lectures):

| Lecture No. | Topic                                                                                       |
|-------------|---------------------------------------------------------------------------------------------|
| 1.          | Introduction to the subject, Types of Measurements                                          |
| 2.          | Types of Instrument performance characteristics of Measurement systems                      |
| 3.          | Types of errors and their causes Combination of errors                                      |
| 4.          | Voltmeter and Multi-range voltmeter Loading and temperature effect of voltmeter performance |
| 5.          | Ammeter and Multi-range Ammeter Loading and temperature effect of Ammeter performance       |
| 6.          | Vector voltmeter Vector impedance meter                                                     |
|             | <b>Measurement using bridge Networks</b>                                                    |
| 7.          | D.C. bridges A.C. bridges                                                                   |
| 8.          | Measurement of inductance using A.C. bridges                                                |
| 9.          | Measurement of capacitance using A.C. bridges                                               |
| 10.         | Measurement of frequency using A.C. bridges Wagner's Earthing device                        |
|             | <b>Cathode ray Oscilloscope</b>                                                             |
| 11.         | CRO basic function and working                                                              |
| 12.         | Types of CRO                                                                                |
| 13.         | Special purpose oscilloscopes                                                               |
| 14.         | Measurement of different quantities using CRO                                               |
|             | <b>Measurement of Non-Electrical Quantities</b>                                             |
| 15.         | Transducers and their classification                                                        |
| 16.         | Thermoelectric Transducer (RTD and Thermister)                                              |
| 17.         | Thermoelectric Transducer (Thermocouple)                                                    |
| 18.         | Strain gauge                                                                                |
| 19.         | LVDT                                                                                        |
| 20.         | Photo electric Transducer, Photo multiplier tube.                                           |

|     |                                                           |
|-----|-----------------------------------------------------------|
| 21. | Photo conductive and voltaic cell                         |
| 22. | Nuclear radiation transducer                              |
|     | <b><i>Signal Generators and Analyzers</i></b>             |
| 23. | Simple generator and function generator                   |
| 24. | Sweep frequency generator                                 |
| 25. | Wave analyzer                                             |
| 26. | Spectrum analyzer                                         |
| 27. | Harmonic distortion analyzer                              |
|     | <b><i>Digital measurement</i></b>                         |
| 28. | Advantages of digital instruments over analog instruments |
| 29. | Digital frequency meter                                   |
| 30. | Digital to analog convertors                              |
| 31. | Ramp type digital voltmeter                               |
| 32. | Integrating type digital voltmeter                        |
| 33. | Successive approximation type digital voltmeter           |
|     | <b><i>Display devices</i></b>                             |
| 34. | LED                                                       |
| 35. | LCD                                                       |
| 36. | Seven segment and 14 segment Display                      |

### **Fifth Semester**

|                                   |                                                                                                                                                                                                              |            |         |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|
| Name of Program                   | B.Tech                                                                                                                                                                                                       | Semester V | YearIII |
| Name of Course                    | Data Structures and Algorithms                                                                                                                                                                               |            |         |
| Course Code                       | CS 352                                                                                                                                                                                                       |            |         |
| Core / Elective / Other           | Core                                                                                                                                                                                                         |            |         |
| Prerequisite:                     |                                                                                                                                                                                                              |            |         |
| 1.                                | One programming language (C,C++)                                                                                                                                                                             |            |         |
| 2.                                | Mathematics                                                                                                                                                                                                  |            |         |
| 3.                                |                                                                                                                                                                                                              |            |         |
| Course Outcomes:                  |                                                                                                                                                                                                              |            |         |
| 1.                                | Be familiar with the use of data structures as the foundational base for computer solutions to problems.                                                                                                     |            |         |
| 2.                                | Become introduced to and investigate the differing logical relationships among various data items.                                                                                                           |            |         |
| 3.                                | Understand the generic principles of computer programming as applied to sophisticated data structures.                                                                                                       |            |         |
| 4.                                | Comprehend alternative implementations using the differing logical relationships and appreciate the significance of choosing a particular logical relationship for implementation within real-world setting. |            |         |
| Description of Contents in brief: |                                                                                                                                                                                                              |            |         |

|    |                                                                                                                                                                                                                                                                |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | <b>Introduction:</b> Data Structure and Abstract data types, Organization of Arrays, Structures, Pointers, Recursion.                                                                                                                                          |
| 2. | <b>Stacks:</b> Stack Implementation and Applications, Prefix Postfix and Infix Conversion, Use of Stack in Recursion.                                                                                                                                          |
| 3. | <b>Queues:</b> Linear Queue and Circular Queue, Applications of Queue. <b>Linked Lists:</b> Type of Linked Lists, Implementation of Stack and Queue using Linked list.                                                                                         |
| 4. | <b>Trees:</b> Tree Concept, Binary Tree and it's Representations, Applications of Binary Tree, Huffman Coding, Binary Search Tree.                                                                                                                             |
| 5. | <b>Graphs:</b> Graph and it's Representations, Algorithms on graph.<br><b>Sorting and Searching:</b> Fundamental Searching algorithms (Sequential Search, Binary Search etc) Fundamental Sorting Algorithms (Selection Sort, Bubble Sort, Insertion Sort etc). |

#### List of Text Books:

|    |                                                                      |
|----|----------------------------------------------------------------------|
| 1. | R. G. Dromey, "How to Solve it by Computer", Prentice-Hall of India. |
| 2. | Data Structures by Schaums Series, TMH                               |
| 3. |                                                                      |

#### List of Reference Books:

|    |                                                                                                      |
|----|------------------------------------------------------------------------------------------------------|
| 1. | Fundamentals of Data Structures in C by Horowitz, Sahni and Anderson-Freed.                          |
| 2. | M. A. Weiss, "Data Structures and Algorithm Analysis in C", 2nd ed, Pearson Education Asia.          |
| 3. | Y. Langsam, M. J. Augenstein and A. M. Tenenbaum, "Data Structures using C", Pearson Education Asia. |

#### URLs:

|    |                                                                                             |
|----|---------------------------------------------------------------------------------------------|
| 1. | <a href="https://nptel.ac.in/courses/106102064/">https://nptel.ac.in/courses/106102064/</a> |
| 2. | <a href="https://nptel.ac.in/courses/106106127/">https://nptel.ac.in/courses/106106127/</a> |
| 3. | <a href="https://nptel.ac.in/courses/106103069/">https://nptel.ac.in/courses/106103069/</a> |

#### Lecture Plan (about 40-50 Lectures):

| Lecture No. | Topic                                                         |
|-------------|---------------------------------------------------------------|
| 1           | Introduction to Data Structure                                |
| 2           | Primitive data type, Abstract data type                       |
| 3           | Time Complexity                                               |
| 4           | Space complexity                                              |
| 5           | Introduction to C/C++, variables, constants, operators, loops |
| 6           | Arrays-one dimension, two dimension array                     |
| 7           | multi-dimension array, programs related to array              |
| 8           | Functions, recursive function                                 |
| 9           | Use of structure in Data structure                            |
| 10          | Concept of pointers                                           |
| 11          | Linked list, operation on linked list, singly linked list     |
| 12          | Circular linked list, doubly linked list                      |
| 13          | Linked list in Arrays, linked list vs Arrays                  |
| 14          | Concept of stack, Implementation of Stack                     |

|    |                                                                           |
|----|---------------------------------------------------------------------------|
| 15 | Representation of stacks through Arrays                                   |
| 16 | Application of Stacks                                                     |
| 17 | Infix to prefix conversion                                                |
| 18 | Postfix conversion                                                        |
| 19 | Concept of Queue                                                          |
| 20 | Implementation of linear Queue using Array                                |
| 21 | Queue as an Abstract data type                                            |
| 22 | Circular Queue                                                            |
| 23 | Double-ended Queue                                                        |
| 24 | Priority Queue                                                            |
| 25 | Representation of stack and queue as linked list                          |
| 26 | Application of Queues                                                     |
| 27 | Concept of Trees, Introduction to Non-linear Data Structure               |
| 28 | Types of trees, Binary Tree, properties and representation of Binary tree |
| 29 | Binary Search Tree                                                        |
| 30 | Binary tree traversal , Application of Binary Tree                        |
| 31 | AVL trees and its representation                                          |
| 32 | Operations on AVL Trees                                                   |
| 33 | Searching and Sorting                                                     |
| 34 | Efficiency of sorting algorithm, bubble sort                              |
| 35 | selection sort, Quick sort                                                |
| 36 | Insertion sort, Merge sort, Heap sort                                     |
| 37 | Introduction to searching, Binary search, sequential search               |
| 38 | Introduction to Graphs, sequential representation of graph                |
| 39 | Linked representation of Graph                                            |
| 40 | Traversal of Graph, Application of Graphs                                 |
| 41 | Djkstras Routing Algorithm                                                |
| 42 | Minimum Spanning Tree                                                     |
| 43 | Hashing. Hash tables. Hash functions. Some examples of hash functions     |
| 44 | Double hashing                                                            |
| 45 | Bucket addressing                                                         |

|                                   |                                                                                                                                                                                                                                                                                                                                 |                             |            |          |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------|----------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                 | B.Tech.                     | Semester V | Year III |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                 | Information Theory & Coding |            |          |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                 | ECE 311                     |            |          |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                 | Core                        |            |          |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                 |                             |            |          |
| 1.                                | Basic exposure to linear algebra                                                                                                                                                                                                                                                                                                |                             |            |          |
| 2.                                | Probability theory                                                                                                                                                                                                                                                                                                              |                             |            |          |
| 3.                                | A course in digital communications                                                                                                                                                                                                                                                                                              |                             |            |          |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                 |                             |            |          |
| 1.                                | In this course we will explore maximum data rate at which we can transmit over a communication link and fundamental limit of data compression                                                                                                                                                                                   |                             |            |          |
| 2.                                | This course will introduce the error control codes – Low Density Parity Check codes and Polar codes - that have been proposed for 5G cellular communication systems.                                                                                                                                                            |                             |            |          |
| 3.                                | Implementation of decoders for codes.                                                                                                                                                                                                                                                                                           |                             |            |          |
| 4.                                | MATLAB simulation of various decoders.                                                                                                                                                                                                                                                                                          |                             |            |          |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                 |                             |            |          |
| 1.                                | Definition of Information Measure and Entropy, extension of An Information source and Markov Source, adjoint of An information Source, Joint and Conditional Information Measure, properties of Joint and Conditional Information Measures and a Morkov Source, asymptotic properties of Entropy and Problem Solving in Entropy |                             |            |          |
| 2.                                | Block Code and its Properties,instantaneous Code and Its Properties,Kraft-Mcmillan Equality and Compact Codes, Shannon's First Theorem, Coding Strategies and Introduction to Huffman Coding, Huffman Coding and Proof of Its Optimality,                                                                                       |                             |            |          |

|                                             |                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | Competitive Optimality of The Shannon Code, Non-Binary Huffman Code and Other Codes, Adaptive Huffman Coding, Shannon-Fano-Elias Coding and Introduction to Arithmetic Coding, Arithmetic Coding                                                                                                                                                                    |
| 3.                                          | Introduction to Information Channels, Equivocation and Mutual Information, Properties of Different Information Channels, Reduction of Information Channels, Properties of Mutual Information and Introduction to Channel Capacity, Calculation of Channel Capacity for Different Information Channels, Shannon's Second Theorem                                     |
| 4.                                          | Differential Entropy and Evaluation of Mutual Information for Continuous Sources and Channels, Channel Capacity of A Band Limited Continuous Channel, Introduction to Rate-Distortion Theory, Definition and Properties of Rate-Distortion Functions, Calculation of Rate Distortion Functions, Computational Approach for Calculation of Rate-Distortion Functions |
| 5.                                          | Introduction to Quantization, Lloyd- Max Quantizer, Companded Quantization, Variable Length Coding and Problem Solving in Quantizer Design, Vector Quantization, Transform Coding.                                                                                                                                                                                  |
| <b>List of Text Books:</b>                  |                                                                                                                                                                                                                                                                                                                                                                     |
| 1.                                          | Digital Communication by Haykins Simon Wiley Publ.                                                                                                                                                                                                                                                                                                                  |
| 2.                                          | Modern analog and Digital Communication system, by B.P. Lathi                                                                                                                                                                                                                                                                                                       |
| 3.                                          | Error control Coding: Theory and Application, by Shu Lin and Costello, PHI                                                                                                                                                                                                                                                                                          |
| <b>List of Reference Books:</b>             |                                                                                                                                                                                                                                                                                                                                                                     |
| 1.                                          | R. Bose, Information theory, coding and cryptography, McGrawHill                                                                                                                                                                                                                                                                                                    |
| 2.                                          | Herbert Taub and Donald Scihiling, "Principles of Communication Systems", McGraw Hill Publication                                                                                                                                                                                                                                                                   |
| 3.                                          | R P Singh and S D Sapre "Communication systems", TMH                                                                                                                                                                                                                                                                                                                |
| <b>URLs:</b>                                |                                                                                                                                                                                                                                                                                                                                                                     |
| 1.                                          | <a href="https://nptel.ac.in/courses/117101053/">https://nptel.ac.in/courses/117101053/</a>                                                                                                                                                                                                                                                                         |
| 2.                                          | <a href="https://nptel.ac.in/courses/108102117/">https://nptel.ac.in/courses/108102117/</a>                                                                                                                                                                                                                                                                         |
| 3.                                          | <a href="https://nptel.ac.in/courses/117/104/117104129/">https://nptel.ac.in/courses/117/104/117104129/</a>                                                                                                                                                                                                                                                         |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                        |
| 1                                           | Introduction to Information Theory and Coding                                                                                                                                                                                                                                                                                                                       |
| 2                                           | Definition of Information Measure and Entropy                                                                                                                                                                                                                                                                                                                       |
| 3                                           | Extension of An Information Source and Markov Source                                                                                                                                                                                                                                                                                                                |
| 4                                           | Adjoint of An Information Source, Joint and Conditional Information Measure                                                                                                                                                                                                                                                                                         |
| 5                                           | Properties of Joint and Conditional Information Measures and A Markov Source                                                                                                                                                                                                                                                                                        |
| 6                                           | Asymptotic Properties of Entropy and Problem Solving in Entropy                                                                                                                                                                                                                                                                                                     |
| 7                                           | Block Code and its Properties                                                                                                                                                                                                                                                                                                                                       |
| 8                                           | Instantaneous Code and Its Properties                                                                                                                                                                                                                                                                                                                               |
| 9                                           | Kraft-McMillan Equality and Compact Codes                                                                                                                                                                                                                                                                                                                           |
| 10                                          | Shannon's First Theorem                                                                                                                                                                                                                                                                                                                                             |
| 11                                          | Coding Strategies and Introduction to Huffman Coding                                                                                                                                                                                                                                                                                                                |
| 12                                          | Huffman Coding and Proof of Its Optimality                                                                                                                                                                                                                                                                                                                          |

|           |                                                                                                              |
|-----------|--------------------------------------------------------------------------------------------------------------|
| <b>13</b> | Competitive Optimality of The Shannon Code                                                                   |
| <b>14</b> | Non-Binary Huffman Code and Other Codes                                                                      |
| <b>15</b> | Adaptive Huffman Coding Part-I                                                                               |
| <b>16</b> | Adaptive Huffman Coding Part-II                                                                              |
| <b>17</b> | Shannon-Fano-Elias Coding and Introduction to Arithmetic Coding                                              |
| <b>18</b> | Arithmetic Coding Part-I                                                                                     |
| <b>19</b> | Arithmetic Coding Part-II                                                                                    |
| <b>20</b> | Introduction to Information Channels                                                                         |
| <b>21</b> | Equivocation and Mutual Information                                                                          |
| <b>22</b> | Properties of Different Information Channels                                                                 |
| <b>23</b> | Reduction of Information Channels                                                                            |
| <b>24</b> | Properties of Mutual Information and Introduction to Channel Capacity                                        |
| <b>25</b> | Calculation of Channel Capacity for Different Information Channels                                           |
| <b>26</b> | Shannon's Second Theorem                                                                                     |
| <b>27</b> | Discussion On Error Free Communication Over Noisy Channel                                                    |
| <b>28</b> | Error Free Communication Over A Binary Symmetric Channel and Introduction to Continuous Sources and Channels |
| <b>29</b> | Differential Entropy and Evaluation of Mutual Information for Continuous Sources and Channels                |
| <b>30</b> | Channel Capacity of A BandLimited Continuous Channel                                                         |
| <b>31</b> | Introduction to Rate-Distortion Theory                                                                       |
| <b>32</b> | Definition and Properties of Rate-Distortion Functions                                                       |
| <b>33</b> | Calculation of Rate-Distortion Functions                                                                     |
| <b>34</b> | Computational Approach for Calculation of Rate-Distortion Functions                                          |
| <b>35</b> | Introduction to Quantization                                                                                 |
| <b>36</b> | Lloyd-Max Quantizer                                                                                          |
| <b>37</b> | Companded Quantization                                                                                       |
| <b>38</b> | Variable Length Coding and Problem Solving in Quantizer Design                                               |
| <b>39</b> | Vector Quantization                                                                                          |
| <b>40</b> | Transform Coding                                                                                             |

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |            |         |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------|---------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                 | B.Tech          | Semester V | Year II |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                 | Control systems |            |         |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                 | ECE 312         |            |         |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                 | Core            |            |         |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |            |         |
| 1.                                | Signal and system                                                                                                                                                                                                                                                                                                                                                                                                               |                 |            |         |
| 2.                                | Network Analysis                                                                                                                                                                                                                                                                                                                                                                                                                |                 |            |         |
| 3.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |            |         |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |            |         |
| CO-1                              | The student will be able to make a comparative analysis of various techniques in modeling control systems.                                                                                                                                                                                                                                                                                                                      |                 |            |         |
| CO-2                              | The student will be able to assess the characteristics of control systems using various tools and to design appropriate compensation technique.                                                                                                                                                                                                                                                                                 |                 |            |         |
| CO-3                              | The student will be able to examine the stability of control systems using various techniques.                                                                                                                                                                                                                                                                                                                                  |                 |            |         |
| CO-4                              | The student will be able to analyze the dynamic behaviour of control systems using state space model.                                                                                                                                                                                                                                                                                                                           |                 |            |         |
| CO-5                              | The student will be able to understand the working principle of PI,PD and PID controllers.                                                                                                                                                                                                                                                                                                                                      |                 |            |         |
| CO-6                              | The student will be able to understand the working principle of sampled data systems.                                                                                                                                                                                                                                                                                                                                           |                 |            |         |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |            |         |
| 1.                                | Terminology and Basic Structure-Feed forward and Feedback control theory-Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system                                                                                                                                                                                    |                 |            |         |
| 2.                                | Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI,PID control systems                                                                                                                                             |                 |            |         |
| 3.                                | Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot — Polar Plot-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation                                                                                                                                                |                 |            |         |
| 4.                                | Concept of stability-Bounded — Input Bounded — Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.                                                                                                                                                                                                                                |                 |            |         |
| 5.                                | State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback. |                 |            |         |

**List of Text Books:**

|    |                                                               |
|----|---------------------------------------------------------------|
| 1. | Electronics Instrumentation & Measurement System A.K. Shawney |
| 2. | Electronics Measurement and Instrumentation Kalsi, PHI        |
| 3. | Control System Engineering Nagrath & Gopal                    |
| 4. | Linear Control System B.S.Manke                               |

**List of Reference Books:**

|    |                                               |
|----|-----------------------------------------------|
| 1. | Modern Control System R.C. Dorf & R.N. Bishop |
| 2. | Modern Control Engineering K. Ogata           |
| 3. | Automatic Control System By B.C. KUO          |

**URLs:**

|    |                                                                                                                                                                                               |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | <a href="https://www.youtube.com/watch?v=vVFDm__CdQw">https://www.youtube.com/watch?v=vVFDm__CdQw</a>                                                                                         |
| 2. | <a href="https://www.youtube.com/watch?v=7LZSjgZz-Qw&amp;list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ">https://www.youtube.com/watch?v=7LZSjgZz-Qw&amp;list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ</a> |
| 3. | <a href="https://nptel.ac.in/courses/107106081/">https://nptel.ac.in/courses/107106081/</a>                                                                                                   |

**Lecture Plan (about 40-50 Lectures):**

| Lecture No. | Topic                                                           |
|-------------|-----------------------------------------------------------------|
| 1           | Concepts of Control Systems                                     |
| 2           | classification of control system and Example of control systems |
| 3           | Mathematical Modeling of servomechanism                         |
| 4           | Block diagram reduction technique                               |
| 5           | Signal flow graph algebra                                       |
| 6           | Tutorials                                                       |
| 7           | Standard test signals                                           |
| 8           | Time response of first order                                    |
| 9           | Time response of second order                                   |
| 10          | steady state error and Error coefficients                       |
| 11          | Proportional control , Derivative control , Integral control    |
| 12          | PID control                                                     |
| 13          | Effect of addition of pole and zero                             |
| 14          | Concept of stability                                            |
| 15          | Routh hurwitz criterion                                         |
| 16          | problems                                                        |
| 17          | Gain margin                                                     |
| 18          | Phase margin                                                    |
| 19          | The root locus concept                                          |
| 20          | construction of root loci                                       |
| 21          | Tutorial                                                        |

|           |                                               |
|-----------|-----------------------------------------------|
| <b>22</b> | Tutorial                                      |
| <b>23</b> | Bode plots                                    |
| <b>24</b> | Tutorial                                      |
| <b>25</b> | Tutorial                                      |
| <b>26</b> | GM and PM -Stability Analysis from Bode Plots |
| <b>27</b> | Numericals                                    |
| <b>28</b> | Nyquist Plots                                 |
| <b>29</b> | Nyquist Stability Criterion                   |
| <b>30</b> | Assessment of relative stability              |
| <b>31</b> | Compensation techniques with bode plot.       |
| <b>32</b> | Compensation techniques with root locus.      |
| <b>33</b> | State equations                               |
| <b>34</b> | Concepts of Controllability                   |
| <b>35</b> | Concepts of Observability                     |
| <b>36</b> | Digital control design using state feedback.  |
| <b>37</b> | Design problems on lag compensation           |
| <b>38</b> | Design problems on lead compensation          |
| <b>39</b> | Design problems on lag-lead compensation      |
| <b>40</b> | tutorial                                      |

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------|----------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                           | B.TECH (ECE)          | Semester V | Year III |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                           | Communication Systems |            |          |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                           | ECE 313               |            |          |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                           | Core                  |            |          |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| 1.                                | Signals and Systems                                                                                                                                                                                                                                                                                                                                                                                                       |                       |            |          |
| 2.                                |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| 3.                                |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| 1.                                | Understand the concepts of analog modulation and demodulation techniques                                                                                                                                                                                                                                                                                                                                                  |                       |            |          |
| 2.                                | Learn the function of radio transmitters and receivers and familiarize with noise performance of various receivers                                                                                                                                                                                                                                                                                                        |                       |            |          |
| 3.                                | Understand various digital modulation schemes and matched filter receiver                                                                                                                                                                                                                                                                                                                                                 |                       |            |          |
| 4.                                | Understand and analyze various digital pass band data transmission schemes                                                                                                                                                                                                                                                                                                                                                |                       |            |          |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| 1.                                | Review of signals and systems, Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems.                                                                                                                                                                                                                                                  |                       |            |          |
| 2.                                | Amplitude modulation - Generation of Amplitude Modulation, Non-linear Modulation – Square law Modulator, Product Modulator, Switching Modulator, Demodulation of Amplitude Modulation – Envelope Detector, Coherent Detector, VSB, Performance comparison of various Amplitude Modulation Systems. Radio Receiver - Tuned Radio Frequency (TRF) Receiver, Superheterodyne Receiver. Noise in amplitude modulation system. |                       |            |          |
| 3.                                | Angle modulation - Frequency Modulation, Generation of NBFM, WBFM, Transmission BW of FM Signal, Phase Modulation. Relationship between PM & FM, Comparison, Generation of FM Direct Method, Indirect method, Demodulation of FM - FM Discriminators. Noise in Frequency modulation systems.                                                                                                                              |                       |            |          |
| 4.                                | Digital communications: PCM, DPCM, Delta modulation. Noise considerations in PCM. Time Division multiplexing, Digital Multiplexers.                                                                                                                                                                                                                                                                                       |                       |            |          |
| 5.                                | Digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation.                                                                                                                                                                                                                 |                       |            |          |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| 1.                                | B.P.Lathi and Z. Ding, “Modern Digital and Analog Communication Systems,4Ed.”, Oxford,2011.                                                                                                                                                                                                                                                                                                                               |                       |            |          |
| 2.                                | HaykinS., "Communications Systems", John Wiley and Sons, 2001.                                                                                                                                                                                                                                                                                                                                                            |                       |            |          |
| 3.                                | Taub H. and Schilling D.L., "Principles of Communication Systems”, Tata McGraw Hill, 2001.                                                                                                                                                                                                                                                                                                                                |                       |            |          |
| List of Reference Books:          |                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |            |          |
| 1.                                | Proakis J. G. and Salehi M., "Communication Systems Engineering”, Pearson Education, 2002.                                                                                                                                                                                                                                                                                                                                |                       |            |          |
| 2.                                | Dennis Reddy & John Coolen, “Electronic Communications”, 4th Edition, Prentice Hall, 2008.                                                                                                                                                                                                                                                                                                                                |                       |            |          |

| 3.                                          | Simon Haykin and Michael Moher, "Communication Systems," 5th edition, John Wiley & Sons, 2013 |
|---------------------------------------------|-----------------------------------------------------------------------------------------------|
| <b>URLs:</b>                                |                                                                                               |
| 1.                                          |                                                                                               |
| 2.                                          |                                                                                               |
| 3.                                          |                                                                                               |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                               |
| Lecture No.                                 | Topic                                                                                         |
| 1.                                          | Review of signals and systems                                                                 |
| 2.                                          | Random variables and Random processes                                                         |
| 3.                                          | Autocorrelation and power spectral density                                                    |
| 4.                                          | Properties of white noise                                                                     |
| 5.                                          | Filtering of random signals through LTI systems                                               |
| 6.                                          | Block diagram of Communication System                                                         |
| 7.                                          | Amplitude modulation generation methods                                                       |
| 8.                                          | DSB-SC, SSB, VSB                                                                              |
| 9.                                          | Demodulation of Amplitude Modulation – Envelope Detector, Coherent Detector                   |
| 10.                                         | TRF Receiver                                                                                  |
| 11.                                         | Superheterodyne Receiver                                                                      |
| 12.                                         | Noise in amplitude modulation system                                                          |
| 13.                                         | Introduction to Angle modulation                                                              |
| 14.                                         | Frequency Modulation, Generation of NBFM, WBFM                                                |
| 15.                                         | Direct and Indirect method of FM generation                                                   |
| 16.                                         | Phase Modulation                                                                              |
| 17.                                         | Demodulation of FM - FM Discriminators                                                        |
| 18.                                         | Superheterodyne Receiver                                                                      |
| 19.                                         | Noise in Frequency modulation systems                                                         |
| 20.                                         | Introduction to Digital communications                                                        |
| 21.                                         | PAM, PPM, PWM                                                                                 |
| 22.                                         | PCM- Sampling, Quantization, Encoding                                                         |
| 23.                                         | Quantization error, $SN_qR$ , BW calculation                                                  |
| 24.                                         | Companding                                                                                    |
| 25.                                         | DPCM, Delta Modulation                                                                        |
| 26.                                         | Delta Modulation, ADM                                                                         |
| 27.                                         | Time Division multiplexing                                                                    |
| 28.                                         | Digital Multiplexers                                                                          |
| 29.                                         | Digital modulation schemes                                                                    |
| 30.                                         | Amplitude, phase and frequency shift keying (ASK, PSK, FSK)                                   |
| 31.                                         | QPSK, M-ary PSK                                                                               |
| 32.                                         | DPSK-transmitter and receiver implementations                                                 |
| 33.                                         | MAP and ML decoding                                                                           |
| 34.                                         | Optimum Receiver and matched filter                                                           |
| 35.                                         | Matched filter receiver                                                                       |
| 36.                                         | Probability of error calculation                                                              |

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|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 37. | Signal Space Representation, Orthogonality, Orthonormality,<br>Representation of Signals In Terms of Orthonormal Basis Functions<br>Signal Space Representation, Orthogonality, Orthonormality,<br>Representation of Signals In Terms of Orthonormal Basis Functions<br>Signal Space Representation, Orthogonality, Orthonormality,<br>Representation of Signals In Terms of Orthonormal Basis Functions<br>Signal Space Representation, Orthogonality, Orthonormality, |
| 38. | Representation of Signals in Terms of Orthonormal Basis Functions                                                                                                                                                                                                                                                                                                                                                                                                       |
| 39. | Constellation Diagram for different signaling schemes                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 40. | Calculation of BW and Energy efficiency                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 41. | Calculation of bandwidth, SNR and BER for digital modulation                                                                                                                                                                                                                                                                                                                                                                                                            |

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------|----------|
| Name of Program                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | B. Tech     | Semester V | Year III |
| Name of Course                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | VLSI Design |            |          |
| Course Code                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ECE 314     |            |          |
| Core / Elective / Other              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Core        |            |          |
| Prerequisite:                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| 1.                                   | The students are well versed with the fundamentals Basic electronics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |            |          |
| 2.                                   | The students are well versed with the fundamentalsDigital electronics.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |            |          |
| 3.                                   | The students are well versed with the fundamentals Micro-electronics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |            |          |
| Course Outcomes:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| 1.                                   | Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |            |          |
| 2.                                   | Students will be able to design MOSFET based logic circuit                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |            |          |
| 3.                                   | Students will be able to draw layout of a given logic circuit                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |            |          |
| 4.                                   | Student will be able to realize logic circuits with different design styles                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |            |          |
| 5.                                   | Student will be able to demonstrate an understanding of working principles of clocking and testing of circuits.                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| Description of Contents in brief:    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| 1.                                   | Introduction to MOS Technology - CMOS fabrication. Basic Electrical Properties - NMOS Inverter, Zpu/Zpd ratio, CMOS Inverter, Regions of Operation. MOS Circuits and logic design: Switching logic, gate logic, Two/Three input NMOS, CMOS&BiCMOS, NAND & NOR gates, CMOS logic structures, clocking strategies. Introduction of VLSI Design Methodologies – Design Description domains. System design and methods - CMOS design methods, CMOS design options. Layout design rules and Stick diagrams. Introduction to VLSI Testing. |             |            |          |
| List of Text Books:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| 1.                                   | Basic VLSI Design Douglas A. Pucknell & Kamran Eshraghian.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |            |          |
| 2.                                   | Principles of CMOS VLSI design Neil H.E. Weste& Kamran Eshraghian                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |            |          |
| List of Reference Books:             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| 1.                                   | CMOS VLSI Design Harris, Weste, Banerjee                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |            |          |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| Lecture No.                          | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |            |          |
| 1.                                   | Review of IC manufacturing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |            |          |
| 2.                                   | N-well and p-well process.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |            |          |
| 3.                                   | CMOS Twin - Tub process.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |            |          |
| 4.                                   | Integrated Circuit – An Overview.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |            |          |
| 5.                                   | Introduction to MOS Technology.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |            |          |
| 6.                                   | Basic Properties of MOS Circuits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |            |          |
| 7.                                   | Basic Electrical Properties - NMOS Inverter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |            |          |
| 8.                                   | Pull-up to Pull-down ratio of nMOS inverter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |            |          |
| 9.                                   | Alternatives forms of Pull-up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |            |          |
| 10.                                  | CMOS Inverter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |            |          |
| 11.                                  | Regions of Operation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |            |          |

|     |                                                                     |
|-----|---------------------------------------------------------------------|
| 12. | Power Dissipation in CMOS circuits                                  |
| 13. | Charge sharing and Latch-up problem.                                |
| 14. | Physical design of logic gates- Switches and Transmission gates.    |
| 15. | CMOS Circuit and Logic design.                                      |
| 16. | BiCMOS invertor                                                     |
| 17. | BiCMOSNAND& NOR gates                                               |
| 18. | CMOS Logic Structures- Pseudo-nMOS logic.                           |
| 19. | Dynamic CMOS logic.                                                 |
| 20. | CMOS Domino logic.                                                  |
| 21. | NP Domino logic.                                                    |
| 22. | Clocking Strategies.                                                |
| 23. | Clock skew.                                                         |
| 24. | Timing issues.                                                      |
| 25. | Setup and Hold Time                                                 |
| 26. | Static and Dynamic timing analysis.                                 |
| 27. | CMOS Design Methods.                                                |
| 28. | Behavioral Synthesis.                                               |
| 29. | Logic optimization.                                                 |
| 30. | Design-Capture Tools.                                               |
| 31. | Chip Composition.                                                   |
| 32. | Design Verification Tools.                                          |
| 33. | Network Isomorphism.                                                |
| 34. | Layout design rules                                                 |
| 35. | Stick diagrams                                                      |
| 36. | CMOS Testing.                                                       |
| 37. | Manufacturing test principles - Fault Modeling, Gate level Testing. |
| 38. | Controllability and Observability                                   |
| 39. | Ad Hoc Testable Design Techniques.                                  |
| 40. | Scan-Based Techniques.                                              |
| 41. | BIST Techniques.                                                    |
| 42. | $I_{DDQ}$ Test.                                                     |

## **Sixth Semester**

|                                         |                                                                                                                                                                        |                             |             |               |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------|---------------|
| Name of Program                         |                                                                                                                                                                        | B. Tech                     | Semester VI | Year III Year |
| Name of Course                          |                                                                                                                                                                        | ENGINEERING MANAGEMENT      |             |               |
| Course Code                             |                                                                                                                                                                        | ME 351                      |             |               |
| Core / Elective / Other                 |                                                                                                                                                                        | Core (for all the branches) |             |               |
| Prerequisite if any:                    |                                                                                                                                                                        |                             |             |               |
| 1.                                      | None                                                                                                                                                                   |                             |             |               |
| Course Outcomes: Students shall develop |                                                                                                                                                                        |                             |             |               |
| 1.                                      | Understanding the relevance and importance of Management Practices for Engineers.                                                                                      |                             |             |               |
| 2.                                      | Knowledge and Practices on the interdisciplinary course content that combines an engineering focus with core business and management knowledge.                        |                             |             |               |
| 3.                                      | Ability to understand various methods of analysis and decision making related to operations, human resources, finances and marketing management.                       |                             |             |               |
| Description of Contents in brief:       |                                                                                                                                                                        |                             |             |               |
| Unit 1.                                 | Principles/Functions of Management, Measure of Productivity and ways to enhance Productivity. Management challenges for Engineers.                                     |                             |             |               |
| Unit 2.                                 | Operations Management and its scope, Production Systems, Facility Location, Facility Planning & Plant Layouts.                                                         |                             |             |               |
| Unit 3.                                 | Industrial Design, Product Design, Product / Project Life Cycle, Quality Control and Quality Management, Forecasting Methods, Introduction to Supply Chain Management. |                             |             |               |
| Unit 4.                                 | Material Management – Purchasing, Inventory & JIT Systems, Material Resource Planning, Scheduling, Project Management, PERT and CPM, Project Crashing.                 |                             |             |               |
| Unit 5.                                 | Introduction to Financial Management, Financial Statements and Analysis, Operations Decision making - Break Even Analysis & Decision Trees                             |                             |             |               |
| Unit 6                                  | Fundamentals of Marketing Management, Organizational Behavior and Leadership, Strategic Management, Statutory and Legal Issues.                                        |                             |             |               |
| List of Text Books:                     |                                                                                                                                                                        |                             |             |               |
| 1.                                      | Modern production/operations management by Buffa: Wiley India                                                                                                          |                             |             |               |
| 2.                                      | Marketing Management by Kotler; PHI                                                                                                                                    |                             |             |               |
| 3.                                      | Operations Management by Russel & Taylor; Wiley                                                                                                                        |                             |             |               |
| List of Reference Books:                |                                                                                                                                                                        |                             |             |               |
| 1.                                      | Handbook of Industrial Engineering: Technology and Operations Management by Gavriel Salvendy; Wiley publication                                                        |                             |             |               |
| 2.                                      | Operations management by Krajewski; pearson                                                                                                                            |                             |             |               |
| 3.                                      | Industrial Engineering by Shankar Ravi; Galgotia Publication                                                                                                           |                             |             |               |
| 4.                                      | Financial Management by I M Pandey; Vikas                                                                                                                              |                             |             |               |
| 5.                                      | Strategic Management by Pearce, Robinson and Mital; Mc Graw Hill Education                                                                                             |                             |             |               |
| URLs:                                   |                                                                                                                                                                        |                             |             |               |
| 1.                                      | <a href="https://nptel.ac.in/courses/112/107/112107238/">https://nptel.ac.in/courses/112/107/112107238/</a>                                                            |                             |             |               |
| 2.                                      | <a href="https://nptel.ac.in/courses/110/107/110107144/">https://nptel.ac.in/courses/110/107/110107144/</a>                                                            |                             |             |               |
| Lecture Plan (about 40-50 Lectures):    |                                                                                                                                                                        |                             |             |               |
| *Lecture No.                            | Topic                                                                                                                                                                  |                             |             | Remarks       |
| 1.                                      | Introduction to the course and its scope                                                                                                                               |                             |             |               |
| 2.                                      | Principles and Functions of Management                                                                                                                                 |                             |             |               |
| 3.                                      | Principles and Functions of Management                                                                                                                                 |                             |             |               |
| 4.                                      | Productivity and its Measures                                                                                                                                          |                             |             |               |
| 5.                                      | Productivity and its Measures                                                                                                                                          |                             |             |               |
| 6.                                      | Ways to enhance Productivity                                                                                                                                           |                             |             |               |
| 7.                                      | Management Challenges for Engineers                                                                                                                                    |                             |             |               |
| 8.                                      | Operations Management and Its Scope                                                                                                                                    |                             |             |               |
| 9.                                      | Production Systems                                                                                                                                                     |                             |             |               |
| 10.                                     | Plant Location and Site Selection – An Introduction                                                                                                                    |                             |             |               |

|     |                                                                                           |  |
|-----|-------------------------------------------------------------------------------------------|--|
| 11. | Factors affecting Plant Location                                                          |  |
| 12. | Plant Layout, Types and characteristics of a good plant layout                            |  |
| 13. | Procedure and Methods of Plant Layout                                                     |  |
| 14. | Procedure and Methods of Plant Layout                                                     |  |
| 15. | Factors affecting Plant Layout                                                            |  |
| 16. | Installation and evaluation of Plant Layout                                               |  |
| 17. | Industrial Design& Morphology of Design                                                   |  |
| 18. | Product Life Cycle                                                                        |  |
| 19. | Product Design and Approaches to Product Design                                           |  |
| 20. | Product Design and Approaches to Product Design                                           |  |
| 21. | Product Design and Approaches to Product Design                                           |  |
| 22. | Introduction to Forecasting Methods                                                       |  |
| 23. | Forecasting Models                                                                        |  |
| 24. | Quality Control and Quality Management - Introduction                                     |  |
| 25. | Quality Circle and Total Quality Management                                               |  |
| 26. | Supply Chain Management                                                                   |  |
| 27. | Characteristics of Supply Chain Management                                                |  |
| 28. | Application of SCM                                                                        |  |
| 29. | Material Management – Purchasing                                                          |  |
| 30. | Inventory Models                                                                          |  |
| 31. | Inventory Models                                                                          |  |
| 32. | JIT Systems                                                                               |  |
| 33. | Material Resource Planning                                                                |  |
| 34. | Introduction to Project Management–<br>Planning, Scheduling & Controlling                 |  |
| 35. | CPM                                                                                       |  |
| 36. | PERT                                                                                      |  |
| 37. | Project Crashing                                                                          |  |
| 38. | Financial management – Introduction & Its interface with other<br>functions of Management |  |
| 39. | Financial Planning, Estimation of Financial Requirements of a<br>Project                  |  |
| 40. | Working Capital Management                                                                |  |
| 41. | Break Even Analysis, Risk Analysis and Decision Trees                                     |  |
| 42. | Concept and Functions of Marketing Management                                             |  |
| 43. | Marketing Process – Marketing Mix                                                         |  |
| 44. | Marketing Environment and Marketing Research                                              |  |
| 45. | Consumer & Business Buyer Behavior                                                        |  |
| 46. | Segmentation & Targeting                                                                  |  |
| 47. | Distribution and Pricing                                                                  |  |
| 48. | Organizational Behavior and Leadership                                                    |  |
| 49. | Organizational Behavior and LeadershipContd                                               |  |
| 50. | Strategic Management                                                                      |  |
| 51. | Statutory and Legal Issues.                                                               |  |

|                                      |                                                                                                                                                                        |                          |             |          |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------------|----------|
| Name of Program                      |                                                                                                                                                                        | B.Tech ECE               | Semester VI | Year III |
| Name of Course                       |                                                                                                                                                                        | Digital Image Processing |             |          |
| Course Code                          |                                                                                                                                                                        | ECE 321                  |             |          |
| Core / Elective / Other              |                                                                                                                                                                        | Core                     |             |          |
| Prerequisite:                        |                                                                                                                                                                        |                          |             |          |
| 1.                                   | Digital Signal Processing                                                                                                                                              |                          |             |          |
| 2.                                   | Probability and Statistics                                                                                                                                             |                          |             |          |
| 3.                                   |                                                                                                                                                                        |                          |             |          |
| Course Outcomes:                     |                                                                                                                                                                        |                          |             |          |
| 1.                                   | Analyze general terminology of digital image processing.                                                                                                               |                          |             |          |
| 2.                                   | Examine various types of images, intensity transformations and spatial filtering                                                                                       |                          |             |          |
| 3.                                   | Evaluate the methodologies for image segmentation, restoration etc.                                                                                                    |                          |             |          |
| 4.                                   | Implement image process and analysis algorithms                                                                                                                        |                          |             |          |
| 5.                                   | Apply image processing algorithms in practical applications                                                                                                            |                          |             |          |
| Description of Contents in brief:    |                                                                                                                                                                        |                          |             |          |
| 1.                                   | Digital Image Fundamentals                                                                                                                                             |                          |             |          |
| 2.                                   | Image Enhancement                                                                                                                                                      |                          |             |          |
| 3.                                   | Morphological operations                                                                                                                                               |                          |             |          |
| 4.                                   | Image Segmentation                                                                                                                                                     |                          |             |          |
| 5.                                   | Image Compression                                                                                                                                                      |                          |             |          |
| List of Text Books:                  |                                                                                                                                                                        |                          |             |          |
| 1.                                   | R.C.Gonzalas and R.E.Woods, Digital Image Processing, Prentice Hall, 3rd Ed                                                                                            |                          |             |          |
| List of Reference Books:             |                                                                                                                                                                        |                          |             |          |
| 1.                                   | A.K.Jain, Fundamentals of Digital Image Processing, Prentice Hall.                                                                                                     |                          |             |          |
| 2.                                   | S.Sridhar, Digital Image Processing, Oxford University Press.                                                                                                          |                          |             |          |
| URLs:                                |                                                                                                                                                                        |                          |             |          |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                        |                          |             |          |
| Lecture No.                          | Topic                                                                                                                                                                  |                          |             |          |
| 1                                    | Fundamental steps in DIP, Components of digital image processing,                                                                                                      |                          |             |          |
| 2                                    | Elements of visual perception, Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, light, Image sensing and acquisition, |                          |             |          |
| 3                                    | Image formation model, definition and some properties of two dimensional system,                                                                                       |                          |             |          |

|    |                                                                                                                                      |
|----|--------------------------------------------------------------------------------------------------------------------------------------|
| 4  | Discrete 2D convolution, 2D discrete Fourier transform and its properties,                                                           |
| 5  | Sampling and quantization of images, Two dimensional sampling theory, representation of digital image,                               |
| 6  | Some basic relationships between pixels.                                                                                             |
| 7  | Image Interpolation                                                                                                                  |
| 8  | Image Interpolation Contd...                                                                                                         |
| 9  | Basics of Image Enhancement                                                                                                          |
| 10 | Gray Level Transformations,                                                                                                          |
| 11 | Piecewise linear transformation, Histogram Processing,                                                                               |
| 12 | Histogram equalization                                                                                                               |
| 13 | Enhancement Using Arithmetic/Logic Operations. Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filters,                |
| 14 | Use of first order and second order derivative in enhancement.                                                                       |
| 15 | Two dimensional Fourier Transform, properties of frequency domain, correspondence between filtering in spatial and frequency domain, |
| 16 | Smoothing and Sharpening frequency domain filters, Homomorphic Filtering.                                                            |
| 17 | Fundamentals of Image Compression, Image compression models,                                                                         |
| 18 | concepts of Information Theory, Fundamental coding theorems, Estimation of entropy,                                                  |
| 19 | Variable length coding,                                                                                                              |
| 20 | Huffman coding, Near optimal variable length coding,                                                                                 |
| 21 | Near optimal variable length coding, Arithmetic coding,                                                                              |
| 22 | Constant area coding, run length coding,                                                                                             |
| 23 | Image compression standards (JPEG, JPEG2000).                                                                                        |
| 24 | Morphological Image Processing fundamentals                                                                                          |
| 25 | Introduction, Logic Operations involving Binary Images, Dilation and Erosion                                                         |
| 26 | Opening and Closing, Morphological Algorithms, Hit or Miss Transformation                                                            |
| 27 | Extraction of Connected component, connected component labeling                                                                      |
| 28 | Boundary Extraction, Region Filling,                                                                                                 |
| 29 | Convex Hull, Thinning, Thickening                                                                                                    |
| 30 | Image Segmentation Fundamentals                                                                                                      |
| 31 | Detection of Discontinuities (point, line edge),                                                                                     |
| 32 | Edge Linking and Boundary Detection,                                                                                                 |
| 33 | Edge Linking and Boundary Detection contd...                                                                                         |
| 34 | Basic global Thresholding,                                                                                                           |
| 35 | Adaptive Thresholding,                                                                                                               |
| 36 | Region-Based Segmentation, region growing,                                                                                           |
| 37 | Region splitting and merging.                                                                                                        |
| 38 | Object Representation and Description fundamentals                                                                                   |
| 39 | Chain code, polygon approximation, signatures                                                                                        |
| 40 | Boundary Segmentation, Skeleton, Shape Number, Fourier Descriptor, Statistical moment                                                |

|                                   |                                                                                                                                                                                                                                                                                                                                             |             |          |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------|
| Name of Program                   | B.Tech                                                                                                                                                                                                                                                                                                                                      | Semester VI | Year III |
| Name of Course                    | Optical Communication                                                                                                                                                                                                                                                                                                                       |             |          |
| Course Code                       | ECE 322                                                                                                                                                                                                                                                                                                                                     |             |          |
| Core / Elective / Other           | Core                                                                                                                                                                                                                                                                                                                                        |             |          |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                             |             |          |
| 1.                                | EM Fields                                                                                                                                                                                                                                                                                                                                   |             |          |
| 2.                                |                                                                                                                                                                                                                                                                                                                                             |             |          |
| 3.                                |                                                                                                                                                                                                                                                                                                                                             |             |          |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                             |             |          |
| CO-1                              | Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.                                                                                                                                                                                                   |             |          |
| CO-2                              | Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers                                                                                                                                                                                                                           |             |          |
| CO-3                              | Describe the principles of optical sources and power launching -coupling methods                                                                                                                                                                                                                                                            |             |          |
| CO-4                              | Compare the characteristics of fiber optic receivers                                                                                                                                                                                                                                                                                        |             |          |
| CO-5                              | Design a fiber optic link based on budgets and assess the different techniques to improve the capacity of the system                                                                                                                                                                                                                        |             |          |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                             |             |          |
| 1.                                | Overview of Optical Fiber Communication: Basic concepts, laws and definition, mode theoryanalysis for optical communication, optical fiber modes and configuration, wave propagation inoptical fiber, operating wavelength, single mode and multimode fibers, V–numbers, mode fielddiameter, numerical aperture, refractive index profiles. |             |          |
| 2.                                | Losses in optical fibers .Dispersion inoptical waveguides, group delay, Design optimization of advance single mode fibers anddispersion compensating fibre. Trends in fiber design.                                                                                                                                                         |             |          |
| 3.                                | Optical Sources & Optical Detectors:Structure, principle and their characteristics, BER. Overview of analog and digital optical link,                                                                                                                                                                                                       |             |          |
| 4.                                | Point to point link system consideration: Link power budget and risc time analysis .Line coding                                                                                                                                                                                                                                             |             |          |
| 5.                                | Fiber Optic Networks, optical amplifiers, WDM & DWDM Optical System, Optical Networks – SONET/SDH, Optical Layer, future of fiber–optic network.                                                                                                                                                                                            |             |          |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                             |             |          |
| 1.                                | Optical Fiber Communication G. Keiser                                                                                                                                                                                                                                                                                                       |             |          |

| 2.                                          | Optical Fiber Communication John M Senior                                                                                                                                                     |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.                                          | Introduction to fiber Optics A. Ghatak& K. Tyagrajan                                                                                                                                          |
| 4.                                          | Fiber optic communication system by Govind P. Agrawal                                                                                                                                         |
| <b>List of Reference Books:</b>             |                                                                                                                                                                                               |
| 1.                                          | Optical Fiber Communication P. Chakrabarti                                                                                                                                                    |
| 2.                                          | Fiber optic communication system by Shiva Kumar                                                                                                                                               |
| 3.                                          | Fiber optic communication system by pierrelecoy                                                                                                                                               |
| <b>URLs:</b>                                |                                                                                                                                                                                               |
| 1.                                          | <a href="https://nptel.ac.in/courses/117101054/">https://nptel.ac.in/courses/117101054/</a>                                                                                                   |
| 2.                                          | <a href="https://nptel.ac.in/courses/117101002/">https://nptel.ac.in/courses/117101002/</a>                                                                                                   |
| 3.                                          | <a href="https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/115107095/lec40.pdf">https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/115107095/lec40.pdf</a> |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                               |
| Lecture No.                                 | Topic                                                                                                                                                                                         |
| 1.                                          | Overview of Optical Fiber Communication                                                                                                                                                       |
| 2.                                          | Basic concepts of optical fiber and Light                                                                                                                                                     |
| 3                                           | Basic laws and definitions, Ray model                                                                                                                                                         |
| 4                                           | Mode theoryanalysis for optical communication, Wave model                                                                                                                                     |
| 5                                           | Different modes in fibers like LP modes                                                                                                                                                       |
| 6                                           | Tutorials                                                                                                                                                                                     |
| 7                                           | Tutorials                                                                                                                                                                                     |
| 8                                           | Wave propagation inoptical fiber, operating wavelength, single mode and multimode fibers, V–numbers                                                                                           |
| 9                                           | Mode fielddiameter, numerical aperture, refractive index profiles.                                                                                                                            |
| 10                                          | Mini test                                                                                                                                                                                     |
| 11                                          | Signal Losses in optical fibers                                                                                                                                                               |
| 12                                          | Scattering loss, Radiation loss                                                                                                                                                               |
| 13                                          | Dispersion inoptical waveguides, Intermodal and intramodal Dispersion                                                                                                                         |
| 14                                          | Design optimization of advance single mode fibers anddispersioncompensatingfibre ,                                                                                                            |
| 15                                          | Dispersion Flattern fiber and dispersion shifted fiber.                                                                                                                                       |
| 16                                          | Optical sources: LED as a course,                                                                                                                                                             |
| 17                                          | Energy band theory ,Characteristics of optical sources.                                                                                                                                       |
| 18                                          | Internal and external Efficiency of the LED, Spectral Bandwidth                                                                                                                               |
| 19                                          | spontaneous and stimulated emission                                                                                                                                                           |
| 20                                          | LASER                                                                                                                                                                                         |
| 21                                          | TUTORIAL                                                                                                                                                                                      |
| 22                                          | TUTORIAL                                                                                                                                                                                      |
| 23                                          | Optical Detectors:Structure, principle and their characteristics                                                                                                                              |

|    |                                  |
|----|----------------------------------|
| 24 | Photo diodes                     |
| 25 | Pin diodes                       |
| 26 | Receiver Sensitivity             |
| 27 | TUTORIAL                         |
| 28 | Fiber optic Link Design          |
| 29 | Link power budget                |
| 30 | rise time analysis               |
| 31 | Line coding                      |
| 32 | Wavelength division Multiplexing |
| 33 | Optical amplifiers               |
| 34 | Optical Amplifier                |
| 35 | Fiber Optic Networks             |
| 36 | DWDM Optical System              |
| 37 | Optical Layer                    |
| 38 | Optical Networks –SONET/SDH      |
| 39 | Future of fiber-optic network.   |
| 40 | Tutorials                        |

|                                   |                                                                                                                                                                   |                       |             |          |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------|----------|
| Name of Program                   |                                                                                                                                                                   | B. Tech.              | Semester VI | Year III |
| Name of Course                    |                                                                                                                                                                   | Microwave Engineering |             |          |
| Course Code                       |                                                                                                                                                                   | ECE 323               |             |          |
| Core / Elective / Other           |                                                                                                                                                                   | Core                  |             |          |
| Prerequisite:                     |                                                                                                                                                                   |                       |             |          |
| 1.                                | Electromagnetic Fields                                                                                                                                            |                       |             |          |
| Course Outcomes:                  |                                                                                                                                                                   |                       |             |          |
| 1.                                | Design impedance matching network for transmission line                                                                                                           |                       |             |          |
| 2.                                | Understand and Analyze parameters and characteristics of the various waveguide components.                                                                        |                       |             |          |
| 3.                                | Analyze microwave power supplies for the transmission of the EM waves.                                                                                            |                       |             |          |
| 4                                 | Acquire knowledge about the measurements to be done at microwaves                                                                                                 |                       |             |          |
| Description of Contents in brief: |                                                                                                                                                                   |                       |             |          |
| 1.                                | Maxwell's and Helmholtz's equations, wave solutions, TEM, TE and TM wave propagation modes, and account for the relevant propagation modes for transmission lines |                       |             |          |
| 2.                                | Calculate the characteristic parameters of a rectangular waveguide                                                                                                |                       |             |          |
| 3.                                | Analysis of Microwave power supplies                                                                                                                              |                       |             |          |
| 4.                                | Scattering parameter analysis                                                                                                                                     |                       |             |          |
| 5.                                | Practical oriented study and analysis for micrometer measurements                                                                                                 |                       |             |          |
| List of Text Books:               |                                                                                                                                                                   |                       |             |          |
| 1.                                | Microwave Devices and Circuits, Samuel Y. Liao, PHI                                                                                                               |                       |             |          |
| 2.                                | Microwave Engineering, David M.Pozar, Wiley India,                                                                                                                |                       |             |          |
| 3.                                | Microwave and Radar Engineering ,M. Kulkarni, Umesh Publications                                                                                                  |                       |             |          |
| List of Reference Books:          |                                                                                                                                                                   |                       |             |          |
| 1.                                | Microwave Principles-Herbert J.Reich, J.G.Skalnik, P.F.Ordung and H.L. Krauss, CBS Publishers                                                                     |                       |             |          |
| 2.                                | Microwave Engineering Passive Circuits-Peter A.Rizzi, PHI                                                                                                         |                       |             |          |
| 3.                                | Electronic and Radio Engineering-F.E Terman, McGraw-Hill                                                                                                          |                       |             |          |
| URLs:                             |                                                                                                                                                                   |                       |             |          |
| 1.                                | <a href="http://www.microwaves101.com/downloads.cfm">http://www.microwaves101.com/downloads.cfm</a>                                                               |                       |             |          |
| 2.                                | <a href="http://ieeexplore.ieee.org/xpl">http://ieeexplore.ieee.org/xpl</a>                                                                                       |                       |             |          |
| 3.                                | <a href="http://www.ycars.org/EFRA">http://www.ycars.org/EFRA</a>                                                                                                 |                       |             |          |

**Lecture Plan (about 40-50 Lectures):**

| <b>Lecture No.</b> |                                                                       |
|--------------------|-----------------------------------------------------------------------|
| 1                  | Characteristic, features and applications of microwaves               |
| 2                  | Rectangular waveguide, TE, mode propagation                           |
| 3                  | TM and TEM mode propagation                                           |
| 4                  | Rectangular waveguide power flow and attenuation in different modes   |
| 5                  | Circular waveguide                                                    |
| 6                  | Numericals                                                            |
| 7                  | Scattering parameters for two port and n port networks                |
| 8                  | Republic Day Holiday                                                  |
| 9                  | Properties of scattering parameter lossless and reciprocal properties |
| 10                 | Scattering parameter for E and H plane tee                            |
| 11                 | Scattering parameter for H plane tee                                  |
| 12                 | Scattering parameter for magic tee                                    |
| 13                 | Scattering parameter for two hole directional coupler                 |
| 14                 | Study of circulator and isolators                                     |
| 15                 | Numericals on scattering matrix and microwave components              |
| 16                 | Two cavity klystron amplifier                                         |
| 17                 | Two cavity klystron amplifier calculation efficiency and applications |
| 18                 | Two cavity klystron amplifier velocity modulation derivation          |
| 19                 | Two cavity klystron amplifier efficiency derivation                   |
| 20                 | Reflex klystron                                                       |
| 21                 | Reflex klystron velocity modulation                                   |
| 22                 | Reflex klystron numericals                                            |
| 23                 | Cylindrical magnetron oscillator                                      |
| 24                 | Linear magnetron oscillator                                           |
| 25                 | Magnetron oscillator                                                  |
| 26                 | Numericals on magnetron                                               |
| 27                 | Tunnel diodes                                                         |
| 28                 | Gunn effect                                                           |
| 29                 | Gunn Diode numericals                                                 |
| 30                 | Avalanche effect                                                      |
| 31                 | PIN diodes and applications                                           |
| 32                 | Planer transmission lines such as stripline                           |
| 33                 | Microstrip line                                                       |
| 34                 | Slotline                                                              |
| 35                 | Technology of hybrid MICs                                             |
| 36                 | Advantages of MICs                                                    |
| 37                 | VSWR measurement                                                      |
| 38                 | Microwave power measurement                                           |
| 39                 | Microwave power measurement                                           |
| 40                 | Frequency measurement                                                 |
| 41                 | Numericals on microwave measurement                                   |

## Seventh Semester

|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                     |                 |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|---------------------|-----------------|
| <b>Name of Program</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>B.TECH</b>                        | <b>Semester-VII</b> | <b>Year :IV</b> |
| <b>Name of Course</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Engineering Economics and IPR</b> |                     |                 |
| <b>Course Code</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>HUM 451</b>                       |                     |                 |
| <b>Core / Elective / Other</b>           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Core (Semester 7 <sup>th</sup> ECE)  |                     |                 |
| <b>Prerequisite:</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                     |                 |
| 1.                                       | Theoretical underpinning of the concepts related to Economics is crucial.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                      |                     |                 |
| 2.                                       | Technical knowledge and basic understanding of IPR laws is important.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                      |                     |                 |
|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                     |                 |
| <b>Course Outcomes:</b>                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                     |                 |
| 1.                                       | Students would be in a position to link the concepts of Economics and Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                      |                     |                 |
| 2.                                       | Understanding the production and related it with cash flow and payments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                      |                     |                 |
| 3.                                       | Students will understand the benefits of IPR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                      |                     |                 |
| 4.                                       | Understanding of Indian laws and acts regarding IPR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                      |                     |                 |
|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                     |                 |
| <b>Description of Contents in Brief:</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                      |                     |                 |
|                                          | <p>1.Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.</p> <p>2.Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.</p> <p>3. Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor – Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.</p> <p>4. Basic concepts, characteristics and nature of Intellectual Property Right, IPR and Economic Development, major international instrument relating to the protection of IP. Meaning, Criteria for obtaining patents, Non Patentable inventions, procedure for registration, term of Patent, Rights of patentee, basic concept of compulsory license and government use of patent, infringement of patents and remedies in case of infringement, Relevant Sections.</p> <p>5. Meaning of mark, trademark, and categories of trademark: Certification Mark and well known mark and Non-conventional marks, concepts of distinctiveness. Designs, GI and other forms of IP, Designs: meaning design protection, concept of original</p> |                                      |                     |                 |

|                                             |                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | design, term of protection, relevant sections. Geographical Indication: meaning of GI, difference between GI and Trade Mark, Concept of Authorized Use, Homonymous GI, Relevant section,. Trade-secret: meaning, Criteria of Protection, relevant sections. Plant Variety, Protection and Farmer's Right: meaning, criteria of protection, relevant sections. |
|                                             |                                                                                                                                                                                                                                                                                                                                                               |
| <b>List of Text Books:</b>                  |                                                                                                                                                                                                                                                                                                                                                               |
| 1.                                          | A. Koutsoyiannis "Modern Microeconomics". Macmillan Education.                                                                                                                                                                                                                                                                                                |
| 2.                                          | Subbaram N.R. "Handbook of Indian Patent Law and Practice ", S. Viswanathan, Printers and Publishers Pvt. Ltd.,1998                                                                                                                                                                                                                                           |
| 3.                                          | Stephen Ross and Randolph Westerfield and Jeffrey Jaffe and Bradford Jordan, "Corporate Finance", McGraw Hill.                                                                                                                                                                                                                                                |
|                                             |                                                                                                                                                                                                                                                                                                                                                               |
| <b>List of Reference Books:</b>             |                                                                                                                                                                                                                                                                                                                                                               |
| 1.                                          | Chan Spark, "Contemporary Engineering Economics", Prentice Hall of India, 2011.                                                                                                                                                                                                                                                                               |
| 2.                                          | Donald. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Egg. Press, Texas, 2010.                                                                                                                                                                                                                                                               |
| 3.                                          | Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.                                                                                                                                                                                                                                                               |
| 4.                                          | Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012                                                                                                                                                                                                                                                                            |
| 5.                                          | V.K. Ahuja , " Law related to Intellectual Property Rights". Publisher- Lexis-Nexi                                                                                                                                                                                                                                                                            |
| 6.                                          | R. Radhakrishnan and S. Balasubramanian, "Intellectual Property Rights- Texts and Cases", publisher- Excel Books India.                                                                                                                                                                                                                                       |
| 7.                                          | A. Koutsoyiannis "Modern Microeconomics". Macmillan Education.                                                                                                                                                                                                                                                                                                |
| 8.                                          | Stephen Ross and Randolph Westerfield and Jeffrey Jaffe and Bradford Jordan, "Corporate Finance", McGraw Hill.                                                                                                                                                                                                                                                |
| <b>URLs:</b>                                |                                                                                                                                                                                                                                                                                                                                                               |
| 1.                                          | <a href="https://nptel.ac.in/courses/109/104/109104125/">https://nptel.ac.in/courses/109/104/109104125/</a>                                                                                                                                                                                                                                                   |
| 2.                                          | <a href="https://nptel.ac.in/courses/110/107/110107144/">https://nptel.ac.in/courses/110/107/110107144/</a>                                                                                                                                                                                                                                                   |
| 3.                                          | <a href="http://www.ipindia.nic.in/">http://www.ipindia.nic.in/</a>                                                                                                                                                                                                                                                                                           |
| 4.                                          | <a href="https://nptel.ac.in/courses/109106100/">https://nptel.ac.in/courses/109106100/</a>                                                                                                                                                                                                                                                                   |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                                                                                                                                                                               |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                  |
| 1                                           | Introduction to Economics and Flow in an economy                                                                                                                                                                                                                                                                                                              |
| 2                                           | Law of supply and demand                                                                                                                                                                                                                                                                                                                                      |
| 3                                           | Concept of Engineering Economics: Engineering efficiency                                                                                                                                                                                                                                                                                                      |
| 4                                           | Economic efficiency                                                                                                                                                                                                                                                                                                                                           |
| 5                                           | Scope of engineering economics                                                                                                                                                                                                                                                                                                                                |
| 6                                           | Element of costs: Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost                                                                                                                                                                                                                                                                                |
| 7                                           | Break-even analysis: PV ratio                                                                                                                                                                                                                                                                                                                                 |
| 8                                           | Elementary economic Analysis: Material selection for product Design selection for a product,                                                                                                                                                                                                                                                                  |

|     |                                                                                                         |
|-----|---------------------------------------------------------------------------------------------------------|
| 9   | Process planning                                                                                        |
| 10  | Methods of comparison of alternatives: present worth method                                             |
| 11  | Revenue dominated cash flow diagram                                                                     |
| 12  | Future worth method (Revenue dominated cash flow diagram)                                               |
| 13  | Future worth method (Cost dominated cash flow diagram)                                                  |
| 14  | Annual equivalent method (Revenue dominated cash flow diagram)                                          |
| 15  | Annual equivalent method (Cost dominated cash flow diagram)                                             |
| 16  | Rate of return method                                                                                   |
| 17  | Make or buy decision, Value engineering: Function, aims, and Value engineering procedure                |
| 18  | Interest formulae and their applications: Time value of money                                           |
| 19  | Single payment compound amount factor                                                                   |
| 20  | Single payment present worth factor                                                                     |
| 21  | Equal payment series sinking fund factor                                                                |
| 22  | Equal payment series capital recovery factor                                                            |
| 23  | Equal payment series capital recovery factor                                                            |
| 24  | Uniform gradient series annual equivalent factor                                                        |
| 25  | Effective interest rate                                                                                 |
|     | <b>Intellectual Property Rights</b>                                                                     |
| 1.  | Introduction to IPR, its Importance, Need and Characteristics                                           |
| 2.  | IPR and Economic Development                                                                            |
| 3.  | Major International Instrument relating to the protection of IP                                         |
| 4.  | Patents : Meaning & Criteria for obtaining Patents                                                      |
| 5.  | Procedure for Registration & Non Patentable inventions                                                  |
| 6.  | Term of Patent and Rights of patentee                                                                   |
| 7.  | Basic concept of Compulsory License                                                                     |
| 8.  | Government use of Patent                                                                                |
| 9.  | Infringement of patents and Remedies in case of Infringement                                            |
| 10. | Relevant Sections of Patents                                                                            |
| 11. | Introduction to Mark and Trademark, Rights and Limitations of Trade Marks                               |
| 12. | Categories of Trademark                                                                                 |
| 13. | Certification Mark, Well known Marks and Non-Conventional Marks                                         |
| 14. | Concepts of Distinctiveness                                                                             |
| 15. | Introduction to Design: Its meaning and Registration process                                            |
| 16. | Meaning of Design Protection, Concept of Original Design, Term of Design                                |
| 17. | Relevant Sections of Design                                                                             |
| 18. | Meaning of Geographical Indication and Difference between GI and Trade Mark                             |
| 19. | Concept of Authorized Use                                                                               |
| 20. | Homonymous GI and Relevant section of GI                                                                |
| 21. | Trade-secret: Meaning, Criteria of Protection, Relevant Sections of it.                                 |
| 22. | Plant Variety, Protection and Farmer's Right: Meaning, Criteria of Protection, Relevant Sections of it. |
| 23. | Case Studies On – Patents (Basmati Rice, Turmeric, Neem, Etc.)                                          |

|                        |               |                     |                |
|------------------------|---------------|---------------------|----------------|
| <b>Name of Program</b> | <b>B.Tech</b> | <b>Semester VII</b> | <b>Year IV</b> |
|------------------------|---------------|---------------------|----------------|

|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <b>Name of Course</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                  | Antenna and Wave propagation |
| <b>Course Code</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                  | ECE 411                      |
| <b>Core / Elective / Other</b>           |                                                                                                                                                                                                                                                                                                                                                                                                                  | core                         |
| <b>Prerequisite:</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| 1.                                       | Vector Algebra                                                                                                                                                                                                                                                                                                                                                                                                   |                              |
| 2.                                       | Microwave Engineering                                                                                                                                                                                                                                                                                                                                                                                            |                              |
| 3.                                       | Network Theorems                                                                                                                                                                                                                                                                                                                                                                                                 |                              |
| <b>Course Outcomes:</b>                  |                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| 1.                                       | CO1: Describe different multiplexing techniques.                                                                                                                                                                                                                                                                                                                                                                 |                              |
| 2.                                       | CO2: Express the concepts of different types of Antenna.                                                                                                                                                                                                                                                                                                                                                         |                              |
| 3.                                       | CO3: Review the performance analysis of array Antenna.                                                                                                                                                                                                                                                                                                                                                           |                              |
| 4                                        | CO4: Outline the microstrip patch antenna its architecture fabrication .                                                                                                                                                                                                                                                                                                                                         |                              |
| 5                                        | CO5: Analyze the Characteristics of a antenna for different network.                                                                                                                                                                                                                                                                                                                                             |                              |
| <b>Description of Contents in brief:</b> |                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| 1.                                       | Radiation, radiation field from current element antenna, radiation power and radiation resistance of short dipole and half dipole antenna.                                                                                                                                                                                                                                                                       |                              |
| 2.                                       | Field and phase of point sources, directivity and gain, direction and gain calculation of short and half wave antenna.                                                                                                                                                                                                                                                                                           |                              |
| 3.                                       | Introduction to antenna as an aperture, effective length, resonant and traveling wave antenna for different wave length, antenna arrays of point sources, two element array                                                                                                                                                                                                                                      |                              |
| 4.                                       | end fire and broad side arrays, uniform linear arrays of N elements, patterns and principal of pattern multiplication, loop and helical antennas                                                                                                                                                                                                                                                                 |                              |
| 5.                                       | Yagi-Uda antenna, folded dipole, turn side, rhombic antenna. Huygens principle, Babinets principles & complimentary antenna, horn antennas, reflector antennas, log periodic antenna, slot antenna,                                                                                                                                                                                                              |                              |
| 6.                                       | polarization measurements, field strength measurement, Feeders for exciting resonant antenna, center fed and end fed, Ground wave propagation surface wave propagation, space wave propagation, reflection of wave by earths surface, reflection coefficient of vertically and horizontally polarized wave, space wave propagation, range of propagation, propagation beyond the line of sight, duct propagation |                              |
| 7.                                       | Troposphere, scatter, field strength of tropospheric wave, ionosphere, virtual heights, critical frequencies, refractive index of ionized region, reflection and refraction of radio waves in ionosphere, influence of earths magnetic field, loss of energy in ionosphere, single hop and multiple hop transmissions, skip distance and maximum usable frequency (MUF).                                         |                              |
| <b>List of Text Books:</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| 1.                                       | Antennas, John D Krauss.                                                                                                                                                                                                                                                                                                                                                                                         |                              |
| 2.                                       | 2. Electromagnetic waves & Radiating Systems Jordan & Balman.                                                                                                                                                                                                                                                                                                                                                    |                              |
| 3.                                       | Antenna & Wave Propagation K.D. Prasad.                                                                                                                                                                                                                                                                                                                                                                          |                              |
| <b>List of Reference Books:</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| 1.                                       | Antennas for all applications J D Kraus & Ronald J. Marhefka.                                                                                                                                                                                                                                                                                                                                                    |                              |

| 2.                                          | Antenna theory C.A. Balanis.                                                                                                                                                                   |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.                                          | Antenna & Wave Propagation A.R. Harish & M. Sachidananda                                                                                                                                       |
| <b>URLs:</b>                                |                                                                                                                                                                                                |
| 1.                                          |                                                                                                                                                                                                |
| 2.                                          |                                                                                                                                                                                                |
| 3.                                          |                                                                                                                                                                                                |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                |
| Lecture No.                                 | Topic                                                                                                                                                                                          |
| 1.                                          | Radiation, radiation field from current element antenna                                                                                                                                        |
| 2.                                          | -----do-----                                                                                                                                                                                   |
| 3.                                          | radiation power and radiation resistance of short dipole and half dipole antenna.                                                                                                              |
| 4.                                          | -----do-----                                                                                                                                                                                   |
| 5.                                          | -----do-----                                                                                                                                                                                   |
| 6                                           | Field and phase of point sources, directivity and gain                                                                                                                                         |
| 7                                           | -----do-----                                                                                                                                                                                   |
| 8                                           | -----do-----                                                                                                                                                                                   |
| 9                                           | direction and gain calculation of short and half wave antenna.                                                                                                                                 |
| 10                                          | -----do-----                                                                                                                                                                                   |
| 11                                          | -----do-----                                                                                                                                                                                   |
| 12                                          | Introduction to antenna as an aperture, effective length, resonant and traveling wave antenna for different wave length,                                                                       |
| 13                                          | -----do-----                                                                                                                                                                                   |
| 14                                          | -----do-----                                                                                                                                                                                   |
| 15                                          | -----do-----                                                                                                                                                                                   |
| 16                                          | antenna arrays of point sources, two element array                                                                                                                                             |
| 17                                          | -----do-----                                                                                                                                                                                   |
| 18                                          | -----do-----                                                                                                                                                                                   |
| 19                                          | end fire and broad side arrays, uniform linear arrays of N elements                                                                                                                            |
| 20                                          | -----do-----                                                                                                                                                                                   |
| 21                                          | -----do-----                                                                                                                                                                                   |
| 22                                          | patterns and principal of pattern multiplication, loop and helical antennas                                                                                                                    |
| 23                                          | -----do-----                                                                                                                                                                                   |
| 24                                          | -----do-----                                                                                                                                                                                   |
| 25                                          | Yagi-Uda antenna, folded dipole, turn side, rhombic antenna. Huygens principle, Babinet's principles & complementary antenna,                                                                  |
| 26                                          | -----do-----                                                                                                                                                                                   |
| 27                                          | -----do-----                                                                                                                                                                                   |
| 28                                          | -----do-----                                                                                                                                                                                   |
| 29                                          | horn antennas, reflector antennas, log periodic antenna, slot antenna,                                                                                                                         |
| 30                                          | -----do-----                                                                                                                                                                                   |
| 31                                          | -----do-----                                                                                                                                                                                   |
| 32                                          | -----do-----                                                                                                                                                                                   |
| 33                                          | polarization measurements, field strength measurement, Feeders for exciting resonant antenna, center fed and end fed, Ground wave propagation surface wave propagation, space wave propagation |
| 34                                          | -----do-----                                                                                                                                                                                   |

|    |                                                                                                                                                                                                          |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 35 | -----do-----                                                                                                                                                                                             |
| 36 | -----do-----                                                                                                                                                                                             |
| 37 | reflection of wave by earths surface, reflection coefficient of vertically and horizontally polarized wave, space wave propagation                                                                       |
| 38 | -----do-----                                                                                                                                                                                             |
| 39 | -----do-----                                                                                                                                                                                             |
| 40 | range of propagation, propagation beyond the line of sight, duct propagation                                                                                                                             |
| 41 | -----do-----                                                                                                                                                                                             |
| 42 | -----do-----                                                                                                                                                                                             |
| 43 | Troposphere, scatter, field strength of tropospheric wave, ionosphere, virtual heights, critical frequencies, refractive index of ionized region, reflection and refraction of radio waves in ionosphere |
| 44 | -----do-----                                                                                                                                                                                             |
| 45 | -----do-----                                                                                                                                                                                             |
| 46 | influence of earths magnetic field, loss of energy in ionosphere, single hop and multiple hop transmissions, skip distance and maximum usable frequency (MUF).                                           |
| 47 |                                                                                                                                                                                                          |
| 48 | -----do-----                                                                                                                                                                                             |

**LIST OF PROGRAMME ELECTIVES (GROUP A)  
FOR 3<sup>rd</sup> YEAR**

| Name of Program | B. Tech | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
|-----------------|---------|---------------------------|---------------------------------------|
|-----------------|---------|---------------------------|---------------------------------------|

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|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Name of Course</b>                       | VLSI Technology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Course Code</b>                          | ECE 351                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Core / Elective / Other</b>              | Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Prerequisite:</b>                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                          | The students are well versed with the fundamentals of CMOS Design                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 2.                                          | The students are well versed with the fundamentals layout rules.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Course Outcomes:</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                          | Students will be able to understand mechanism of wafer preparation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 2.                                          | Able to demonstrate working of various equipment's for fabrication techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3.                                          | Able to describe models of processes like epitaxy, diffusion, oxidation, etching etch & their dependence on various parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4.                                          | To provide knowledge of various material deposition techniques and electronic/VLSI device                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 5.                                          | Understand the fabrication process of IC technology.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Description of Contents in brief:</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                             | Introduction to VLSI Technology: Classification of ICs, features of ICs , monolithic and hybrid ICs. Crystal Growth and Wafer Preparation: silicon crystal growth from the melt, crystal orientations, various defects in crystal, wafer preparation and wafer specifications. Epitaxy: Epitaxy and its concepts, growth kinetics of epitaxy, vapour phase epitaxy, molecular beam epitaxy. Oxidation: Theory of growth of silicon dioxide layer, calculation of SiO <sub>2</sub> thickness and oxidation kinetics. Lithography- Photolithography and pattern transfer, optical and electron photolithography, X-ray and ion beam lithography. photoresist, types of photoresist. Etching- dry & wet etching. Diffusion Process- Diffusion in solids, diffusion equation and diffusion mechanisms. Ion implantation- Implantation equipments, high energy implantation, scattering phenomenon, range of implanted ions, implantation damage, annealing. Metallization- Metallization applications, metallization choices, physical vapour deposition, patterning & problems in metallization. Thick and thin film deposition. VLSI process integration – NMOS, CMOS, BJT. Assembly techniques, packing of VLSI devices. |
| <b>List of Text Books:</b>                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                          | S.K. Ghandhi, "VLSI Fabrication Principles", John Wiley Inc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2.                                          | S.M. Sze,"VLSI Technology", McGraw Hill.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>List of Reference Books:</b>             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                          | C.Y. Chang and S.M.Sze ,"ULSI Technology", McGraw Hill.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2.                                          | James D. Plummer, "Silicon VLSI Technology: Fundamentals, Practice and Modeling", Pearson Education.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Lecture No. | Topic                                                   |
|-------------|---------------------------------------------------------|
| 1.          | Introduction to VLSI Technology: Classification of ICs. |
| 2.          | Features of ICs , monolithic and hybrid ICs.            |
| 3.          | Refining of Silicon for Crystal Growth.                 |
| 4.          | Refining of Silicon for Crystal Growth contd...         |
| 5.          | Wafer Preparation.                                      |
| 6.          | Wafer Preparation contd...                              |
| 7.          | Crystal orientation.                                    |
| 8.          | Defects in crystal.                                     |
| 9.          | Epitaxy: Epitaxy and its concepts.                      |
| 10.         | Growth kinetics of epitaxy.                             |
| 11.         | Vapour phase epitaxy.                                   |
| 12.         | Molecular beam epitaxy.                                 |
| 13.         | Oxidation: Theory of growth of silicon dioxide layer.   |
| 14.         | Calculation of SiO <sub>2</sub> thickness.              |
| 15.         | Oxidation kinetics.                                     |
| 16.         | Lithography- Photolithography and pattern transfer.     |
| 17.         | Optical photolithography                                |
| 18.         | Electron photolithography.                              |
| 19.         | X-ray and ion beam lithography.                         |
| 20.         | Types of photoresist.                                   |
| 21.         | Etching- dry etching.                                   |
| 22.         | Wet etching.                                            |
| 23.         | Diffusion Process.                                      |
| 24.         | Diffusion in solids.                                    |
| 25.         | Diffusion equation and diffusion mechanisms.            |
| 26.         | Diffusion equation and diffusion mechanismscontd....    |
| 27.         | Implantation equipments.                                |
| 28.         | High energy implantation                                |
| 29.         | Scattering phenomenon                                   |
| 30.         | Range theory of implanted ions.                         |
| 31.         | Implantation damage.                                    |
| 32.         | Annealing.                                              |
| 33.         | Metallization- Metallization applications               |
| 34.         | Metallization choices.                                  |
| 35.         | Physical vapour deposition.                             |
| 36.         | Patterning & problems in metallization.                 |
| 37.         | Thick film deposition.                                  |
| 38.         | Thin film deposition.                                   |
| 39.         | VLSI process integration – NMOS, CMOS, BJT.             |
| 40.         | VLSI process integration –BJT.                          |
| 41.         | Assembly techniques.                                    |
| 42.         | Packing of VLSI devices.                                |

|                        |                       |                                  |                                              |
|------------------------|-----------------------|----------------------------------|----------------------------------------------|
| <b>Name of Program</b> | B.TECH                | <b>Semester</b><br>V/VI/VII/VIII | <b>Year</b> 3 <sup>rd</sup> /4 <sup>th</sup> |
| <b>Name of Course</b>  | DIGITAL SYSTEM DESIGN |                                  |                                              |

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Course Code                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ECE 352                                                                                                    |
| Core / Elective / Other              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Elective                                                                                                   |
| Prerequisite:                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 1.                                   | Digital Electronics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                            |
| Course Outcomes:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 1.                                   | CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Ability to analysis & synthesis of synchronous and asynchronous sequential circuit design.                 |
| 2.                                   | CO 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To understand the concepts of ASM for digital circuit design and implementation in practical applications. |
| 3.                                   | CO 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Design digital system by using PLD's, PLA and PAL.                                                         |
| 4                                    | CO 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Understand and explain the basic concepts of ASIC, CPLD and FPGA                                           |
| 5                                    | CO 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To impart an understanding of the basic concepts of digital system modeling                                |
| Description of Contents in brief:    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 1.                                   | Synchronous Sequential Logic Circuit Design: Introduction, Moore, Mealy and Mixed type Synchronous State Machines. Synchronous Counter Design, Hazards, Duality of sequential circuits, Different methods of minimization. Asynchronous Sequential logic design- Introduction, Primitive flow table and reduction, type of delays, Cycles and races, Excitation Map, Hazards, Essential hazards. Algorithmic State Machine, ASM charts, Design Procedure for ASMs. Fault Diagnosis in Sequential Circuits Introduction to programmable logic devices: PALs, PLDs, CPLDs and FPGAs. ASICs – Full custom, gate array based, standard cell based and Programmable ASICs, Antifuse, SRAM, EEPROM/ EPROM Technologies for Programmable ASICs. |                                                                                                            |
| List of Text Books:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 1.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| List of Reference Books:             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 1.                                   | Donald D.Givone, “Digital Principles and Design”, Tata McGraw-Hill                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                            |
| 2.                                   | M.Morris Mano, “Digital Design”, 3rd edition, Pearson Education                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 3.                                   | Charles H.Roth, Jr. “Fundamentals of Logic Design”, 4th Edition, Jaico Publishing House                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                            |
| URLs:                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 1.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 2.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| 3.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                            |
| Lecture No.                          | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                            |
| 1.                                   | Review of sequential circuits, Mealy-Moore Circuits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                            |
| 2.                                   | Analysis of clocked synchronous sequential networks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                            |
| 3.                                   | Modeling of clocked synchronous sequential network behavior                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                            |
| 4.                                   | State table reduction, state assignment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                            |
| 5.                                   | Design of clocked synchronous sequential networks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                            |
| 6.                                   | Numerical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                            |
| 7.                                   | Structure and operation of Asynchronous sequential network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                            |

|            |                                                                      |
|------------|----------------------------------------------------------------------|
| <b>8.</b>  | Races in Asynchronous sequential networks                            |
| <b>9.</b>  | Primitive flow table, reduction of input restricted flow tables      |
| <b>10.</b> | Problems on reduction of input restricted flow tables                |
| <b>11.</b> | General procedure to flow table reduction                            |
| <b>12.</b> | State assignment problem and transition table                        |
| <b>13.</b> | Design of Asynchronous sequential networks                           |
| <b>14.</b> | Static, dynamic and essential hazards                                |
| <b>15.</b> | Problems based on hazards in combinational networks                  |
| <b>16.</b> | Problems on synchronous and asynchronous networks                    |
| <b>17.</b> | Algorithmic state machines                                           |
| <b>18.</b> | Examples on ASM charts                                               |
| <b>19.</b> | ASM transition and excitation tables                                 |
| <b>20.</b> | ASM realization using gates and multiplexers                         |
| <b>21.</b> | ASM realization using PLA, PLD's and PROMs                           |
| <b>22.</b> | Problems on ASM charts                                               |
| <b>23.</b> | Introduction to CPLD" & FPGA"s.                                      |
| <b>24.</b> | Digital system modeling:Behavioral, structural and physical domains. |
| <b>25.</b> | Fault modelling.                                                     |
| <b>26.</b> | Fault modelling                                                      |
| <b>27.</b> | ASICs-introduction and its types                                     |
| <b>28.</b> | Anti-fuse Technologies for Programmable ASICs.                       |
| <b>29.</b> | SRAM Technologies for Programmable ASICs.                            |
| <b>30.</b> | EEPROM/EPROM Technologies for Programmable ASICs.                    |

|                                   |                                                                                                                                                                     |                     |                           |                                       |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                     | B. Tech.            | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                     | Design of Analog IC |                           |                                       |
| Course Code                       |                                                                                                                                                                     | ECE 353             |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                     | Elective            |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                     |                     |                           |                                       |
| 1.                                | Knowledge of MOS Transistors                                                                                                                                        |                     |                           |                                       |
| 2.                                |                                                                                                                                                                     |                     |                           |                                       |
| 3.                                |                                                                                                                                                                     |                     |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                     |                     |                           |                                       |
| 1.                                | Design and analysis of analog integrated circuits.                                                                                                                  |                     |                           |                                       |
| 2.                                | Optimization in analog Integrated circuit design                                                                                                                    |                     |                           |                                       |
| 3.                                | Numerical in the area of analog integrated circuits.                                                                                                                |                     |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                     |                     |                           |                                       |
| 1.                                | Design CMOS analog circuits.                                                                                                                                        |                     |                           |                                       |
| 2.                                | Noise and distortion in analog circuits                                                                                                                             |                     |                           |                                       |
| 3.                                | Analyze and Design of analog IC                                                                                                                                     |                     |                           |                                       |
| 4.                                | Small and large signal modeling and analysis. Different Single stage and Differential Amplifiers, Current Mirrors, operational amplifier, switch capacitor circuits |                     |                           |                                       |
| 5.                                | Optimization and trade-offs involved in analog integrated circuit design                                                                                            |                     |                           |                                       |
| List of Text Books:               |                                                                                                                                                                     |                     |                           |                                       |
| 1.                                | Behzad Razavi, “Design of Analog CMOS Integrated Circuits” ,McGrawHill                                                                                              |                     |                           |                                       |
| 2.                                | Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer , “Analysis and Design of Analog Integrated Circuit”, John Wiley & Sons                          |                     |                           |                                       |
| 3.                                | Willy Sansen, “Analog Design Essentials”, Springer                                                                                                                  |                     |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                     |                     |                           |                                       |
| 1.                                | David Johns & Ken Martin, Analog Integrated Circuit Design, Wiley-India,                                                                                            |                     |                           |                                       |
| 2.                                | P. Allen & D. R. Holberg, CMOS Analog Circuit Design, Oxford Press,                                                                                                 |                     |                           |                                       |
| 3.                                | P. Gray, P. Hurst, S. Lewis, R. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley-In                                                                  |                     |                           |                                       |
| URLs:                             |                                                                                                                                                                     |                     |                           |                                       |
| 1.                                | www.analogic.com                                                                                                                                                    |                     |                           |                                       |
| 2.                                | www.anylogic.com/resources/books/free-simulation-book-and-modeling-tutorials                                                                                        |                     |                           |                                       |
| 3.                                | <a href="http://www.electronicshub.org/cmos-technology">www.electronicshub.org/cmos-technology</a>                                                                  |                     |                           |                                       |

| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                   |
|---------------------------------------------|-------------------------------------------------------------------|
| <b>Lecture No.</b>                          | <b>Topic</b>                                                      |
| 1                                           | Introduction to Analog circuit design                             |
| 2                                           | General Concepts of Analog IC Design                              |
| 3                                           | Performance parameter for analog design                           |
| 4                                           | Single-Stage Amplifier                                            |
| 5                                           | Numerical on Common-Source Stage amplifier                        |
| 6                                           | Source Follower                                                   |
| 7                                           | Common-Gate Stage                                                 |
| 8                                           | Numerical on Common-Gate Stage amplifier                          |
| 9                                           | Cascode Stage and choice of Device Models                         |
| 10                                          | Single Ended and Differential Operation of Differential Amplifier |
| 11                                          | Basic Differential Pair                                           |
| 12                                          | Common-Mode Response                                              |
| 13                                          | Differential Pair with MOS Loads                                  |
| 14                                          | Numerical on differential pair                                    |
| 15                                          | Basic and Cascode Current Mirrors                                 |
| 16                                          | Active Current Mirrors                                            |
| 17                                          | General Consideration of Amplifiers                               |
| 18                                          | Common-Source Stage                                               |
| 19                                          | Active load                                                       |
| 20                                          | Frequency response                                                |
| 21                                          | Cascode Stage and Differential Pair                               |
| 22                                          | Characteristics and Types of Noise                                |
| 23                                          | Representation of Noise in Circuit                                |
| 24                                          | Noise in Single Stage Amplifier                                   |
| 25                                          | Noise in Differential Pair and Noise Bandwidth                    |
| 26                                          | General Consideration and Feedback Topologies                     |
| 27                                          | Effect of Loading and Effect of Feedback on the Noise             |

|    |                                                                         |
|----|-------------------------------------------------------------------------|
| 28 | Operational Amplifier Considerations and Types of Operational Amplifier |
| 29 | Compensation of Two-Stage Op Amps and Other Techniques                  |
| 30 | Gain Boosting                                                           |
| 31 | Common-Mode Feedback                                                    |
| 32 | Input Rate Limitation and Slew Rate                                     |
| 33 | Power Supply Rejection and Noise in Op-Amp                              |
| 34 | Mutlipole System and Phase Margin                                       |
| 35 | Frequency Consideration                                                 |
| 36 | Stability and frequency compenasion                                     |
| 37 | Introduction to Switched-Capacitor Circuits                             |
| 38 | Sampling Techniques                                                     |
| 39 | Switched-Capacitors Amplifiers                                          |
| 40 | Switched-Capacitor common mode feedback                                 |
| 41 | Numerical on Switched-Capacitors Amplifiers                             |

|                                   |                                                                                                                                                                                                                                                                                                                    |                           |                                       |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------|
| Name of Program                   | B TECH                                                                                                                                                                                                                                                                                                             | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    | Telecom switching system                                                                                                                                                                                                                                                                                           |                           |                                       |
| Course Code                       | ECE 354                                                                                                                                                                                                                                                                                                            |                           |                                       |
| Core / Elective / Other           | Elective                                                                                                                                                                                                                                                                                                           |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                    |                           |                                       |
| 1.                                | Computer Communication and Networks                                                                                                                                                                                                                                                                                |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                    |                           |                                       |
| 1.                                | CO1: Describe different multiplexing techniques                                                                                                                                                                                                                                                                    |                           |                                       |
| 2.                                | CO2: Express the concepts of Digital Switching.                                                                                                                                                                                                                                                                    |                           |                                       |
| 3.                                | CO3: Review the performance analysis of network traffic.                                                                                                                                                                                                                                                           |                           |                                       |
| 4.                                | CO4: Outline the ISDN architecture and Digital Loop Carrier Systems.                                                                                                                                                                                                                                               |                           |                                       |
| 5.                                | CO5: Analyze the Characteristics of a network.                                                                                                                                                                                                                                                                     |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                    |                           |                                       |
| 1.                                | Basic of Switching System, Simple Telephone Communication, Manual Switching System, Major Telecommunication Networks                                                                                                                                                                                               |                           |                                       |
| 2.                                | Digital Switching: Switching Functions, Space Division Switching, Time Division Switching, two dimensional Switching                                                                                                                                                                                               |                           |                                       |
| 3.                                | Traffic Engineering, Queuing systems: Erlang Distribution, probability of delay, Finite queue capacity, systems with a single server, Queues in tandem, delay tables and application of Delay formulae.                                                                                                            |                           |                                       |
| 4.                                | Telephone Networks: Subscriber Loop System, Switching Hierarchy And Routing, Transmission Plan, Transmission System Numbering Plan, Charging Plan, Signaling Techniques, In-channel Signaling, Common Channel Signaling, Cellular Mobile Telephony.                                                                |                           |                                       |
| 5.                                | Digital Subscriber Access : ISDN: ISDN Basic Rate Access Architecture, ISDN U Interface, ISDN D Channel Protocol. High-Data-Rate Digital Subscriber Loops: Asymmetric Digital Subscriber Line, VDSL. Digital Loop Carrier Systems: Universal Digital Loop Carrier Systems, Integrated Digital Loop Carrier Systems |                           |                                       |
| 6.                                | Cellular Mobile Telephony.                                                                                                                                                                                                                                                                                         |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                    |                           |                                       |
| 1.                                | Thiagarajan Viswanathan & Manav Bhatnagar, “Telecommunication Switching Systems and Networks”, PHI.                                                                                                                                                                                                                |                           |                                       |
| 2.                                | J.E. Flood, Telecommunications Switching, Traffic and Networks, Prentice Hall, 1995                                                                                                                                                                                                                                |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                                                                                                                                                                    |                           |                                       |
| 1.                                | James Martin, “Telecomm. & the Computers”, PHI.                                                                                                                                                                                                                                                                    |                           |                                       |

| 2.                                          | Network Traffic Engineering: Models and Applicationsby Andrea Baiocchi Aug 11, 2020       |
|---------------------------------------------|-------------------------------------------------------------------------------------------|
| <b>URLs:</b>                                |                                                                                           |
| 1.                                          | <a href="http://www.kopykitab.com/product/7654">http://www.kopykitab.com/product/7654</a> |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                           |
| Lecture No.                                 | Topic                                                                                     |
| 1.                                          | Basic of Switching System, Simple Telephone Communication                                 |
| 2.                                          | Manual Switching System, Major Telecommunication Networks Strowger                        |
| 3.                                          | Rotary Dial Telephone Signaling Tones, Step by Step Switching                             |
| 4.                                          | Design Parameters, Crossbar Switching: Principal of Common Control                        |
| 5.                                          | Tutorial-1                                                                                |
| 6.                                          | Touch Tone Dial Telephone                                                                 |
| 7.                                          | Principals of Crossbar Switching                                                          |
| 8.                                          | Digital Switching: Switching Functions, , ,.                                              |
| 9.                                          | Space Division Switching                                                                  |
| 10.                                         | Time Division Switching                                                                   |
| 11.                                         | Two dimensional Switching: STS Switching, TST Switching                                   |
| 12.                                         | Digital Cross- Connect Systems                                                            |
| 13.                                         | Digital Switching in an Analog Environment                                                |
| 14.                                         | Traffic Engineering: Queuing systems                                                      |
| 15.                                         | Tutorial-2                                                                                |
| 16.                                         | Erlang Distribution, probability of delay                                                 |
| 17.                                         | Finite queue capacity, systems with a single server                                       |
| 18.                                         | Queues in tandem, delay tables and application of Delay formulae                          |
| 19.                                         | Analysis: Traffic Characteristics: Arrival Distributions, Holding time Distribution.      |
| 20.                                         | Loss Systems: Lost calls cleared                                                          |
| 21.                                         | lost calls returning, lost calls Held, lost calls cleared                                 |
| 22.                                         | Tutorial-3                                                                                |
| 23.                                         | Telephone Networks: Subscriber Loop System                                                |
| 24.                                         | Switching Hierarchy And Routing                                                           |
| 25.                                         | Transmission Plan                                                                         |
| 26.                                         | Transmission System                                                                       |
| 27.                                         | Numbering Plan,                                                                           |
| 28.                                         | Charging Plan,                                                                            |
| 29.                                         | Signaling Techniques In-channel Signaling, Common Channel Signaling                       |
| 30.                                         | Cellular Mobile Telephony                                                                 |
| 31.                                         | Tutorial-3                                                                                |
| 32.                                         | Digital Subscriber Access.                                                                |
| 33.                                         | ISDN: ISDN Basic Rate Access Architecture                                                 |
| 34.                                         | ISDN U Interface, ISDN D Channel Protocol                                                 |
| 35.                                         | High-Data-Rate Digital Subscriber Loops                                                   |
| 36.                                         | Asymmetric Digital Subscriber Line,                                                       |
| 37.                                         | VDSL.                                                                                     |

|     |                                         |
|-----|-----------------------------------------|
| 38. | Digital Loop Carrier Systems            |
| 39. | Universal Digital Loop Carrier Systems  |
| 40. | Integrated Digital Loop Carrier Systems |
| 41. | Tutorial-4                              |

|                        |                         |                                         |                                              |
|------------------------|-------------------------|-----------------------------------------|----------------------------------------------|
| <b>Name of Program</b> | B. Tech                 | <b>Semester</b><br><b>V/VI/VII/VIII</b> | <b>Year</b> 3 <sup>rd</sup> /4 <sup>th</sup> |
| <b>Name of Course</b>  | Satellite Communication |                                         |                                              |

|                                          |                                                                                                                                                                            |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Course Code</b>                       | ECE 355                                                                                                                                                                    |
| <b>Core / Elective / Other</b>           | Elective                                                                                                                                                                   |
| <b>Prerequisite:</b>                     |                                                                                                                                                                            |
| 1.                                       | Basic concepts of analog communication systems                                                                                                                             |
| 2.                                       | Basic concepts of digital communication systems                                                                                                                            |
| <b>Course Outcomes:</b>                  |                                                                                                                                                                            |
| 1.                                       | After studying this course the students would know the principles, concepts and operation of communication satellite systems.                                              |
| 2.                                       | Describe the concepts of orbital mechanism, link design, rain fading and multiple access techniques used in satellite systems.                                             |
| 3.                                       | Use software tools to simulate and analyse the performance of satellite communication systems, link analysis with given data and multiplexing techniques.                  |
| 4.                                       | Students would acquire the knowledge of different types of satellite systems and their applications.                                                                       |
| <b>Description of Contents in brief:</b> |                                                                                                                                                                            |
| 1.                                       | Introduction, History of Satellites, Kepler's law, Elements of orbital mechanics. Equations of motion. Tracking and orbit determination.                                   |
| 2.                                       | Orbital correction/control. Satellite launch systems. Geostationary Satellites, Satellite System Parameters Elements of communication satellite design.                    |
| 3.                                       | Spacecraft subsystems. Reliability considerations. Spacecraft integration.                                                                                                 |
| 4.                                       | Multiple access techniques. FDMA, TDMA, CDMA. Random access techniques. Satellite onboard processing.                                                                      |
| 5.                                       | Satellite link design: Performance requirements and standards. Design of satellite links – DOMSAT, INSAT, Intelsat and Inmarsat. Satellite - based personal communication. |
| 6.                                       | Earth station design. Configuration. Antenna and tracking systems. Satellite broadcasting.                                                                                 |
| <b>List of Text Books:</b>               |                                                                                                                                                                            |
| 1.                                       | Design of Geosynchronous Spacecraft by B.N. Agrawal                                                                                                                        |
| 2.                                       | Satellite Communications by Robert M. Gagliardi                                                                                                                            |
| <b>List of Reference Books:</b>          |                                                                                                                                                                            |
| 1.                                       | Satellite Communication by D.Roddy                                                                                                                                         |
| 2.                                       | Satellite Communication by T.Pratt and C.W. Bostain                                                                                                                        |
| <b>URLs:</b>                             |                                                                                                                                                                            |
| 1.                                       | <a href="https://en.wikipedia.org/wiki/Communications_satellite">https://en.wikipedia.org/wiki/Communications_satellite</a>                                                |

**Lecture Plan (about 40-50 Lectures):**

| <b>Lecture No.</b> | <b>Topic</b>                                                           |
|--------------------|------------------------------------------------------------------------|
| 1.                 | Introduction and history of satellite communication                    |
| 2.                 | Kepler's Law                                                           |
| 3.                 | Elements of Orbital Mechanics                                          |
| 4.                 | Equation of motion                                                     |
| 5.                 | Tutorial                                                               |
| 6.                 | Tracking and Orbit Determination                                       |
| 7.                 | Orbital correction/control                                             |
| 8.                 | Orbital correction/control                                             |
| 9.                 | Tutorial                                                               |
| 10.                | Launchers                                                              |
| 11.                | Satellite Launch Systems                                               |
| 12.                | Geostationary Satellites                                               |
| 13.                | Satellite System Parameters Elements of Communication Satellite Design |
| 14.                | Satellite System Parameters Elements of Communication Satellite Design |
| 15.                | Spacecraft Subsystem                                                   |
| 16.                | Spacecraft Subsystem                                                   |
| 17.                | Tutorial                                                               |
| 18.                | Space Segment subsystem                                                |
| 19.                | Earth Segment Subsystem                                                |
| 20.                | Reliability Consideration                                              |
| 21.                | Spacecraft Integration                                                 |
| 22.                | Modulation Techniques of Satellite Links                               |
| 23.                | Tutorial                                                               |
| 24.                | Multiple Access Techniques                                             |
| 25.                | Multiple Access Techniques                                             |
| 26.                | Single Access Vs Multiple Access                                       |
| 27.                | FDMA                                                                   |
| 28.                | TDMA                                                                   |
| 29.                | CDMA                                                                   |
| 30.                | Tutorial                                                               |
| 31.                | Onboard Signal Processing for FDMA/TDMA Operation                      |
| 32.                | Random Access Techniques                                               |
| 33.                | Satellite onboard processing                                           |
| 34.                | Performance requirements and standards                                 |
| 35.                | Tutorial                                                               |
| 36.                | DOMSAT                                                                 |
| 37.                | INSAT                                                                  |
| 38.                | Intelsat                                                               |
| 39.                | Inmarsat                                                               |
| 40.                | Satellite Based Personal Communication                                 |
| 41.                | Tutorial                                                               |
| 42.                | Earth Station Design                                                   |
| 43.                | Example of Earth Stations                                              |
| 44.                | Configuration of Satellite link Design                                 |
| 45.                | Configuration of Satellite link Design                                 |

|    |                              |
|----|------------------------------|
| 46 | Antenna and Tracking Systems |
| 47 | Satellite Broadcasting       |

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|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                     | B. Tech.                | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                     | Optimization Techniques |                           |                                       |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                     | ECE 356                 |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                     | Elective                |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| 1.                                | Fundamentals of Computing and Programming                                                                                                                                                                                                                                                                                                                                                                                           |                         |                           |                                       |
| 2.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| 3.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| 1.                                | Use classical optimization techniques and numerical methods of optimization                                                                                                                                                                                                                                                                                                                                                         |                         |                           |                                       |
| 2.                                | Describe the basics of different evolutionary algorithms.                                                                                                                                                                                                                                                                                                                                                                           |                         |                           |                                       |
| 3.                                | Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.                                                                                                                                                                                                                                                                       |                         |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| 1.                                | mathematical review for optimization,matrixfactorizations,sets and sequences, convex setsand functions                                                                                                                                                                                                                                                                                                                              |                         |                           |                                       |
| 2.                                | linear programming ,simplex method, Weierstrass' theorem, Karush Kuhn Tucker optimality conditions                                                                                                                                                                                                                                                                                                                                  |                         |                           |                                       |
| 3.                                | Algorithms for optimization I, Algorithms for optimization II, Algorithms for optimization III, Algorithms for optimization IV, Algorithms for optimization V                                                                                                                                                                                                                                                                       |                         |                           |                                       |
| 4.                                | Convergence, unconstrained optimization, Linesearch methods method of multidimensional search I , method of multidimensional search II, Simplex algorithm                                                                                                                                                                                                                                                                           |                         |                           |                                       |
| 5.                                | steepest descent methods I, steepest descent methods II, steepest descent methods III, Gradient Search Methods I, Gradient Search Methods II, Gradient Search Methods III, Newton's method, modifications to Newton's method, trust region methods I, trust region methods II, conjugate gradient methods I, conjugate gradient methods II                                                                                          |                         |                           |                                       |
| 6.                                | Newton's method, modifications to Newton's method, trust region methods I, trust region methods II, conjugate gradient methods I, conjugate gradient methods II<br>Constrained optimization, quasi-Newton's methods I, quasi-Newton's methods II<br>penalty and barrier function methods I, penalty and barrier function methods II, augmented Lagrangian methods, successive linear programming, Successive quadratic programming. |                         |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| 1.                                | Practical Optimization R. Fletcher.                                                                                                                                                                                                                                                                                                                                                                                                 |                         |                           |                                       |
| 2.                                | Nonlinear Programming, Theory and Algorithms, M.S.Bazara, H.D.SheraliandC.Shetty                                                                                                                                                                                                                                                                                                                                                    |                         |                           |                                       |
| 3.                                | Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers                                                                                                                                                                                                                                                                                                                                                                |                         |                           |                                       |
|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                           |                                       |
| 1.                                | Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers 3                                                                                                                                                                                                                                                                                                                        |                         |                           |                                       |
| 2.                                | Operations Research by Hillar and Liberman, TMH Publishers                                                                                                                                                                                                                                                                                                                                                                          |                         |                           |                                       |
| 3.                                | Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers                                                                                                                                                                                                                                                                                                                                                              |                         |                           |                                       |

| <b>URLs:</b>                                |                                                                                                                                                                                     |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                                          | <a href="https://books.google.co.in/books/about/Advanced_Optimization_Techniques">https://books.google.co.in/books/about/Advanced_Optimization_Techniques</a>                       |
| 2.                                          | <a href="https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L4slides.pdf">https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L4slides.pdf</a> |
| 3.                                          |                                                                                                                                                                                     |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                     |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                                        |
| 1                                           | mathematical review for optimization                                                                                                                                                |
| 2                                           | matrix factorizations                                                                                                                                                               |
| 3                                           | sets and sequences                                                                                                                                                                  |
| 4                                           | convex sets and functions                                                                                                                                                           |
| 5                                           | linear programming                                                                                                                                                                  |
| 6                                           | simplex method                                                                                                                                                                      |
| 7                                           | Weierstrass' theorem                                                                                                                                                                |
| 8                                           | Karush Kuhn Tucker optimality conditions                                                                                                                                            |
| 9                                           | Algorithms for optimization I                                                                                                                                                       |
| 10                                          | Algorithms for optimization II                                                                                                                                                      |
| 11                                          | Algorithms for optimization III                                                                                                                                                     |
| 12                                          | Algorithms for optimization IV                                                                                                                                                      |
| 13                                          | Algorithms for optimization V                                                                                                                                                       |
| 14                                          | convergence                                                                                                                                                                         |
| 15                                          | unconstrained optimization                                                                                                                                                          |
| 16                                          | Line search methods                                                                                                                                                                 |
| 17                                          | method of multidimensional search I                                                                                                                                                 |
| 18                                          | method of multidimensional search II                                                                                                                                                |
| 19                                          | Simplex algorithm                                                                                                                                                                   |
| 20                                          | steepest descent methods I                                                                                                                                                          |
| 21                                          | steepest descent methods II                                                                                                                                                         |
| 22                                          | steepest descent methods III                                                                                                                                                        |
| 23                                          | Gradient Search Methods I                                                                                                                                                           |
| 24                                          | Gradient Search Methods II                                                                                                                                                          |

|    |                                                  |
|----|--------------------------------------------------|
| 25 | Gradient Search Methods III                      |
| 26 | Newton's method                                  |
| 27 | modifications to Newton's method                 |
| 28 | trust region methods I                           |
| 29 | trust region methods II                          |
| 30 | conjugate gradient methods I                     |
| 31 | conjugate gradient methods II                    |
| 32 | Constrained optimization                         |
| 33 | quasi-Newton's methods I                         |
| 34 | quasi-Newton's methods II                        |
| 35 | penalty and barrier function methods I           |
| 36 | penalty and barrier function methods II          |
| 37 | augmented Lagrangian methods                     |
| 38 | polynomial time algorithm for linear programming |
| 39 | successive linear programming                    |
| 40 | Successive quadratic programming.                |

|                                      |                                                                                                |                           |                                       |
|--------------------------------------|------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------|
| Name of Program                      | BTECH                                                                                          | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       | Computer Networks                                                                              |                           |                                       |
| Course Code                          | ECE 357                                                                                        |                           |                                       |
| Core / Elective / Other              | Elective                                                                                       |                           |                                       |
| Prerequisite:                        |                                                                                                |                           |                                       |
| 1.                                   | Introduction to telephony                                                                      |                           |                                       |
| 2.                                   | Integrated networks                                                                            |                           |                                       |
| 3.                                   | Multiplexing schematics                                                                        |                           |                                       |
| Course Outcomes:                     |                                                                                                |                           |                                       |
| 1.                                   | Explain the networks, topologies and layers of OSI model,compare with TCP/IP model.            |                           |                                       |
| 2.                                   | Classify error control and flow control techniques and typesof LAN technologies.               |                           |                                       |
| 3.                                   | Analyze different routing algorithms and methods to improve QOS.                               |                           |                                       |
| 4.                                   | Summarize the transport layer protocols and congestion controls methods.                       |                           |                                       |
| 5.                                   | Describe various application layer services and cryptographic techniques                       |                           |                                       |
| Description of Contents in brief:    |                                                                                                |                           |                                       |
| 1.                                   | Introduction Concepts: Goals and Applications of Networks,OSI and TCP-IP Model                 |                           |                                       |
| 2.                                   | Physical Layer, Transmission Media, Line coding                                                |                           |                                       |
| 3.                                   | Functions of Data link layer and DLL Protocols,MAC layer protocols                             |                           |                                       |
| 4.                                   | Network layer and routing algorithms                                                           |                           |                                       |
| 5.                                   | Transport Layer: TCP and UDP, Application Layer, Other application. Overview of IEEE standards |                           |                                       |
| 6.                                   | Example of Networks – Internet, Public Switched Network (PSTN), ISDN, B-ISDN and ATM Networks. |                           |                                       |
| List of Text Books:                  |                                                                                                |                           |                                       |
| 1.                                   | Data Communication and Networking Forouzen                                                     |                           |                                       |
| 2.                                   | Computer Networks A.S. Tanenbaum                                                               |                           |                                       |
| 3.                                   | Data and Computer Communication W. Stallings.                                                  |                           |                                       |
| List of Reference Books:             |                                                                                                |                           |                                       |
| 1.                                   | Data Networks D.P. Bertsekas, R.G. Gallager                                                    |                           |                                       |
| 2.                                   | ISDN and B-ISDN W. Stallings                                                                   |                           |                                       |
| URLs:                                |                                                                                                |                           |                                       |
| 1.                                   | <a href="http://www.saylor.org/courses/cs402/">http://www.saylor.org/courses/cs402/</a>        |                           |                                       |
| 2.                                   | <a href="http://www.cs.vu.nl/~ast/">http://www.cs.vu.nl/~ast/</a>                              |                           |                                       |
| 3.                                   | <a href="https://onlinecourses.nptel.ac">https://onlinecourses.nptel.ac</a> .                  |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                |                           |                                       |

| Lecture No. | Topic                                                                                   |
|-------------|-----------------------------------------------------------------------------------------|
| 1.          | Introduction Concepts: Goals and Applications of Networks, Flow Control                 |
| 2.          | Network Topologies and architecture                                                     |
| 3.          | The OSI reference model                                                                 |
| 4.          | Physical Layer, Transmission Media                                                      |
| 5.          | Line coding: Uni-polar, Bi-polar, RZ, NRZ, Manchester and Differential Manchester codes |
| 6.          | Switching methods Circuit, message, packet switchings                                   |
| 7.          | Functions of Data link layer                                                            |
| 8.          | Framing, Error control                                                                  |
| 9.          | DLL protocol stop and wait                                                              |
| 10.         | Sliding window protocols,                                                               |
| 11.         | Tutorial-1                                                                              |
| 12.         | Medium Access control (MAC) sub layer                                                   |
| 13.         | MAC protocols: ALOHA                                                                    |
| 14.         | Slotted ALOHA                                                                           |
| 15.         | Token bus, Token Ring,                                                                  |
| 16.         | Round Robin, CSMA/CA,                                                                   |
| 17.         | Bit mapped protocol, Carrier Sense Multiple Access (CSMA)                               |
| 18.         | Collision Avoidance, Collision Detection                                                |
| 19.         | p-Persistent, 1-Persistent                                                              |
| 20.         | Non-Persistent spectrum sensing                                                         |
| 21.         | Ethernet frame                                                                          |
| 22.         | Tutorial-2                                                                              |
| 23.         | Network Layer                                                                           |
| 24.         | logical addressing (i.e. IPv4 addresses and header                                      |
| 25.         | Routing algorithms                                                                      |
| 26.         | Least cost routing algorithms                                                           |
| 27.         | Dijkstra and Bellman Ford algorithms                                                    |
| 28.         | Transport Layer: TCP and UDP                                                            |
| 29.         | Application Layer, Other application.                                                   |
| 30.         | Overview of IEEE standards                                                              |
| 31.         | IEEE 802.3(LAN)                                                                         |
| 32.         | IEEE 802.11a,b,g,n (WLAN)                                                               |
| 33.         | IEEE 802.15 (PAN)                                                                       |
| 34.         | FDDI                                                                                    |
| 35.         | Tutorial-3                                                                              |
| 36.         | Networking Devices: Bridge                                                              |
| 37.         | Hub, Switch, Router                                                                     |
| 38.         | Gateway, Servers                                                                        |
| 39.         | Example of Networks – Internet                                                          |
| 40.         | Cryptography                                                                            |
| 41.         | ISDN, B-ISDN and ATM Networks                                                           |
| 42.         | Tutorial-4                                                                              |

|                                   |                                                                                                                                                                                                                                                                                                                          |                           |                                       |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------|
| Name of Program                   | B. Tech                                                                                                                                                                                                                                                                                                                  | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    | Computer Engineering                                                                                                                                                                                                                                                                                                     |                           |                                       |
| Course Code                       | ECE 358                                                                                                                                                                                                                                                                                                                  |                           |                                       |
| Core / Elective / Other           | Elective                                                                                                                                                                                                                                                                                                                 |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                          |                           |                                       |
| 1.                                | The students are well versed with the fundamentals Basic electronics.                                                                                                                                                                                                                                                    |                           |                                       |
| 2.                                | The students are well versed with the fundamentals Digital electronics.                                                                                                                                                                                                                                                  |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                          |                           |                                       |
| 1.                                | The students will be able to describe the fundamental organisation of a computer system.                                                                                                                                                                                                                                 |                           |                                       |
| 2.                                | The students will be able to explain the functional units of a processor.                                                                                                                                                                                                                                                |                           |                                       |
| 3.                                | The students will be able to explain addressing modes, instruction formats and program control statements.                                                                                                                                                                                                               |                           |                                       |
| 4.                                | The students will be able to distinguish the organization of various parts of a system memory hierarchy.                                                                                                                                                                                                                 |                           |                                       |
| 5.                                | The students will be able to describe basic concept of parallel computing.                                                                                                                                                                                                                                               |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                          |                           |                                       |
| 1.                                | Basic building blocks of a computer, Register transfer language, Register transfer, Bus implementation via multiplexer and three-state buffer, arithmetic, logic and shift microoperations and their hardware implementation. Implementation of ALU. Instruction format, instruction set and different addressing modes. |                           |                                       |
| 2.                                | Control unit organization – Hardwired and micro programmed control unit, address sequencing, micro instruction format, routines, microprogramming, micro program sequencer.                                                                                                                                              |                           |                                       |
| 3.                                | Computer arithmetic – Number representation, hardware and algorithms for fixed point and floating point arithmetic– addition, subtraction, multiplication and division. Parallel processing, Flynn’s classification, Pipelining.                                                                                         |                           |                                       |
| 4.                                | Input/Output organization- Peripheral devices, Input-Output interface, data transfer schemes, modes of transfer, Priority interrupt, DMA, I/O processors.                                                                                                                                                                |                           |                                       |
| 5.                                | Memory management – Memory hierarchy, Main memory, Auxiliary memory, Associative memory, Cache memory, Virtual memory.<br>Introduction of system software components: operating system, assembler, linker, compiler.                                                                                                     |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                          |                           |                                       |
| 1.                                | M. Moris Mano, “Computer Systems Architecture”, 4th Edition, Pearson/PHI, ISBN:10:0131755633                                                                                                                                                                                                                             |                           |                                       |
| 2.                                | Carl Hamacher, Zvonko Vranesic, Safwat Zaky, “Computer Organization”, 5 th Edition, McGraw Hill.                                                                                                                                                                                                                         |                           |                                       |

| 3.                                          | Gear C. W., “Computer Organization and Programming”, McGraw Hill.                                                                  |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>List of Reference Books:</b>             |                                                                                                                                    |
| 1.                                          | John L. Hennessy and David A. Patterson, “Computer Architecture a quantitative approach”, 4th Edition Elsevier, ISBN:10:0123704901 |
| 2.                                          | William Stallings, “Computer Organization and Architecture”, 6th Edition, Pearson/PHI, ISBN:10:0-13-609704-9                       |
| 3.                                          | Tennenbaum, “Structured Computer Organization”, PHI.                                                                               |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                    |
| Lecture No.                                 | Topic                                                                                                                              |
| 1.                                          | Basic building blocks of a computer.                                                                                               |
| 2.                                          | Register transfer language.                                                                                                        |
| 3.                                          | Register transfer.                                                                                                                 |
| 4.                                          | Bus implementation via multiplexer.                                                                                                |
| 5.                                          | Three-state buffer.                                                                                                                |
| 6.                                          | Arithmetic, logic and shift microoperations and their hardware implementation.                                                     |
| 7.                                          | Arithmetic, logic and shift microoperations and their hardware implementationcontd.....                                            |
| 8.                                          | Implementation of ALU.                                                                                                             |
| 9.                                          | Instruction format, instruction set.                                                                                               |
| 10.                                         | Different addressing modes.                                                                                                        |
| 11.                                         | Control unit organization – Hardwired and micro programmed control unit.                                                           |
| 12.                                         | Control unit organization – Hardwired and micro programmed control unit contd.....                                                 |
| 13.                                         | Address sequencing.                                                                                                                |
| 14.                                         | Micro instruction format.                                                                                                          |
| 15.                                         | Routines.                                                                                                                          |
| 16.                                         | Microprogramming.                                                                                                                  |
| 17.                                         | Micro program sequencer.                                                                                                           |
| 18.                                         | Computer arithmetic – Number representation.                                                                                       |
| 19.                                         | Hardware and algorithms for fixed point and floating point arithmetic– addition, subtraction, multiplication and division.         |
| 20.                                         | Hardware and algorithms for fixed point and floating point arithmetic– addition, subtraction, multiplication and divisioncontd.... |
| 21.                                         | Hardware and algorithms for fixed point and floating point arithmetic– addition, subtraction, multiplication and divisioncontd.... |
| 22.                                         | Hardware and algorithms for fixed point and floating point arithmetic– addition, subtraction, multiplication and divisioncontd.... |
| 23.                                         | Hardware and algorithms for fixed point and floating point arithmetic– addition, subtraction, multiplication and divisioncontd.... |
| 24.                                         | Parallel processing.                                                                                                               |
| 25.                                         | Flynn’s classification.                                                                                                            |
| 26.                                         | Pipelining.                                                                                                                        |
| 27.                                         | Input/Output organization- Peripheral devices.                                                                                     |
| 28.                                         | Input/Output organization- Peripheral devicescontd....                                                                             |
| 29.                                         | Input-Output interface.                                                                                                            |

|     |                                                              |
|-----|--------------------------------------------------------------|
| 30. | Data transfer schemes.                                       |
| 31. | Modes of transfer.                                           |
| 32. | Priority interrupt.                                          |
| 33. | DMA                                                          |
| 34. | I/O processors                                               |
| 35. | Memory management – Memory hierarchy.                        |
| 36. | Main memory                                                  |
| 37. | Auxiliary memory                                             |
| 38. | Associative memory                                           |
| 39. | Cache memory                                                 |
| 40. | Virtual memor                                                |
| 41. | Introduction of system software components: operating system |
| 42. | Assembler                                                    |
| 43. | Linker                                                       |
| 44. | Compiler                                                     |

### **ELECTIVES FOR 4<sup>TH</sup> YEAR**

|                                      |                                                                                                                                       |                            |                           |                                       |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------|---------------------------------------|
| Name of Program                      |                                                                                                                                       | B. Tech.                   | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                                       | Physical Design Automation |                           |                                       |
| Course Code                          |                                                                                                                                       | ECE 451                    |                           |                                       |
| Core / Elective / Other              |                                                                                                                                       | Elective                   |                           |                                       |
| Prerequisite:                        |                                                                                                                                       |                            |                           |                                       |
| 1.                                   | VLSI Design                                                                                                                           |                            |                           |                                       |
| 2.                                   |                                                                                                                                       |                            |                           |                                       |
| 3.                                   |                                                                                                                                       |                            |                           |                                       |
| Course Outcomes:                     |                                                                                                                                       |                            |                           |                                       |
| 1.                                   | Study automation process for VLSI System design                                                                                       |                            |                           |                                       |
| 2.                                   | Understanding of fundamentals for various physical design CAD tools.                                                                  |                            |                           |                                       |
| 3.                                   | Develop and enhance the existing algorithms and computational techniques for physical design process of VLSI systems                  |                            |                           |                                       |
| Description of Contents in brief:    |                                                                                                                                       |                            |                           |                                       |
| 1.                                   | The course introduce the basic design fow in VLSI physical design automation.                                                         |                            |                           |                                       |
| 2.                                   | Basic data structures and algorithms used for implementing                                                                            |                            |                           |                                       |
| 3.                                   | Examples and assignments to understand the concepts involved in physical design automation and appreciate the main challenges therein |                            |                           |                                       |
| List of Text Books:                  |                                                                                                                                       |                            |                           |                                       |
| 1.                                   | N.A. Sherwani, “Algorithms for VLSI Physical Design Automation”, „Kluwer Academic                                                     |                            |                           |                                       |
| 2.                                   | Sadiq M Sait, “VLSI Physical Design Automation: Theory and Practice                                                                   |                            |                           |                                       |
| List of Reference Books:             |                                                                                                                                       |                            |                           |                                       |
| 1.                                   | Gerez,Sabih H., “Algorithms for VLSI Design Automation”, John Wiley & Sons                                                            |                            |                           |                                       |
| 2.                                   | Drechsler, Rolf, “Evolutionary Algorithms for VLSI CAD” Springer Science & Business Media                                             |                            |                           |                                       |
| 3.                                   | Trimberger, Stephen M., “An Introduction to CAD for VLSI”, Springer Science & Business Media                                          |                            |                           |                                       |
| URLs:                                |                                                                                                                                       |                            |                           |                                       |
| 1.                                   | <a href="http://www.worldscientific.com">www.worldscientific.com</a> › VLSI DESIGN AUTOMATION                                         |                            |                           |                                       |
| 2.                                   | <a href="http://www.electronicshub.org/cmos-technology">www.electronicshub.org/cmos-technology</a>                                    |                            |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                       |                            |                           |                                       |
|                                      |                                                                                                                                       |                            |                           |                                       |
| Lecture No.                          | Topic                                                                                                                                 |                            |                           |                                       |
| 1                                    | Design Representation                                                                                                                 |                            |                           |                                       |
| 2                                    | VLSI Design cycle                                                                                                                     |                            |                           |                                       |
| 3                                    | VLSI Design Styles                                                                                                                    |                            |                           |                                       |

|    |                                          |
|----|------------------------------------------|
| 4  | VLSI Physical Design Automation (Part 1) |
| 5  | VLSI Physical Design Automation (Part 2) |
| 6  | Partitioning                             |
| 7  | Floor planning                           |
| 8  | Floor planning Algorithms                |
| 9  | Pin Assignment                           |
| 10 | Placement (Part 1)                       |
| 11 | Placement (Part 2)                       |
| 12 | Grid Routing (Part 1)                    |
| 13 | Grid Routing (Part 2)                    |
| 14 | Global Routing (Part 1)                  |
| 15 | Global Routing (Part 2)                  |
| 16 | Detailed Routing (Part 1)                |
| 17 | Detailed Routing (Part 2)                |
| 18 | Clock Design (Part 1)                    |
| 19 | Clock Design (Part 2)                    |
| 20 | Clock and Network synthesis              |
| 21 | POWER AND GROUND ROUTING                 |
| 22 | Time Closure                             |
| 23 | Timing Driven Placement                  |
| 24 | Timing Driven Routing                    |
| 25 | Physical Synthesis (Part 1)              |
| 26 | Performance-Driven Design Flow           |
| 27 | Interconnect Modeling                    |
| 28 | Design Rule Check                        |
| 29 | Layout Compaction                        |
| 30 | Test Pattern Generation                  |
| 31 | Design for Testability                   |
| 32 | Boundary Scan Standard                   |
| 33 | Built-in Self-Test (Part 1)              |
| 34 | Low Power VLSI Design                    |
| 35 | Techniques to Reduce Power               |
| 36 | Gate Level Design for Low Power          |

|    |                                                   |
|----|---------------------------------------------------|
| 37 | Algorithmic Level Techniques for Low Power Design |
| 38 | PDA                                               |
| 39 | FPGAs                                             |
| 40 | MCMs                                              |

|                                      |                                                                                                                      |                          |                           |                                       |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------|---------------------------|---------------------------------------|
| Name of Program                      |                                                                                                                      | B. Tech.                 | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                      | CMOS RF circuit Design   |                           |                                       |
| Course Code                          |                                                                                                                      | ECE 452                  |                           |                                       |
| Core / Elective / Other              |                                                                                                                      | Elective                 |                           |                                       |
| Prerequisite:                        |                                                                                                                      |                          |                           |                                       |
| 1.                                   | Knowledge of MOS Transistors                                                                                         |                          |                           |                                       |
| 2.                                   | Design of Analog CMOS circuit                                                                                        |                          |                           |                                       |
| 3.                                   |                                                                                                                      |                          |                           |                                       |
| Course Outcomes:                     |                                                                                                                      |                          |                           |                                       |
| 1.                                   | Understand principles, analysis, and design of CMOS Radio frequency (RF) circuits for wireless communication systems |                          |                           |                                       |
| 2.                                   | Understand principles, analysis, and design of CMOS Radio frequency (RF) circuits for wireless communication systems |                          |                           |                                       |
| 3.                                   | Design of Components in CMOS RF Circuit                                                                              |                          |                           |                                       |
| Description of Contents in brief:    |                                                                                                                      |                          |                           |                                       |
| 1.                                   | RF Transceiver system design concept                                                                                 |                          |                           |                                       |
| 2.                                   | Device Noise calculation and analysis                                                                                |                          |                           |                                       |
| 3.                                   | low-noise amplifiers (LNA) designs,                                                                                  |                          |                           |                                       |
| 4.                                   | Power amplifier design                                                                                               |                          |                           |                                       |
| 5.                                   | Oscillators Ring , LC cross-coupled, Colpitts, Hartly, Voltage control oscillators                                   |                          |                           |                                       |
| List of Text Books:                  |                                                                                                                      |                          |                           |                                       |
| 1.                                   | B. Razavi , “RF Microelectronics”, Prentice Hall of India                                                            |                          |                           |                                       |
| 2.                                   | R. Jacob Baker, H.W. Li and D.E. Boyce, “CMOS Circuit Design, Layout and Simulation”,Prentice Hall of India          |                          |                           |                                       |
| 3.                                   | Thomas H. Lee “Design of CMOS RF Integrated Circuits”, Cambridge University press                                    |                          |                           |                                       |
| List of Reference Books:             |                                                                                                                      |                          |                           |                                       |
| 1.                                   | Y.P. Tsividis, “Mixed Analog and Digital VLSI Devices and Technology”, McGraw Hill.                                  |                          |                           |                                       |
| 2.                                   | P. Allen & D. R. Holberg, CMOS Analog Circuit Design, Oxford Press,                                                  |                          |                           |                                       |
| 3.                                   | P. Gray, P. Hurst, S. Lewis, R. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley-In                   |                          |                           |                                       |
| URLs:                                |                                                                                                                      |                          |                           |                                       |
| 1.                                   | www.CMOScircuit.com                                                                                                  |                          |                           |                                       |
| 2.                                   | www.anylogic.com/resources/books/free-simulation-book-and-modeling-tutorials                                         |                          |                           |                                       |
| 3.                                   | www.electronicshub.org/cmos-technology                                                                               |                          |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                      |                          |                           |                                       |
| Lecture No.                          |                                                                                                                      | Topic                    |                           |                                       |
| 1                                    |                                                                                                                      | Transceiver architecture |                           |                                       |

|    |                                                            |
|----|------------------------------------------------------------|
| 2  | Transmitter and receiver design                            |
| 3  | MOS small signal model                                     |
| 4  | MOS large signal model                                     |
| 5  | Analysis of different types of noise in RF communication   |
| 6  | Derivations on Thermal noise                               |
| 7  | Device noise                                               |
| 8  | Flicker noise                                              |
| 9  | Numericals on different types of noise in RF communication |
| 10 | Analysis of different capacitances in MOSFET               |
| 11 | Passive devices                                            |
| 12 | Uses of passive devices in RF circuit design               |
| 13 | RF inductor design                                         |
| 14 | MOS varactor design                                        |
| 15 | Building block in RF systems                               |
| 16 | Oscillators in RF communication system                     |
| 17 | Common source amplifier                                    |
| 18 | Ring oscillator design using single common source stage    |
| 19 | Ring oscillator design using two common source stage       |
| 20 | Ring oscillator design using multiple common source stage  |
| 21 | Numericals on Ring oscillator                              |
| 22 | One port view of oscillator                                |
| 23 | LC oscillator                                              |
| 24 | Conversion of series resistance to parallel                |
| 25 | Cross coupled LC Oscillator design                         |
| 26 | Numericals on LC Oscillator                                |
| 27 | Cross coupled Oscillator                                   |
| 28 | Numericals on Cross coupled Oscillator                     |
| 29 | Voltage Control Oscillator                                 |

|    |                                               |
|----|-----------------------------------------------|
| 30 | VCO tuning range limitations                  |
| 31 | Numericals on VCO                             |
| 32 | Basics of LNA, important parameters           |
| 33 | LNA design issues                             |
| 34 | LNA broadband topology                        |
| 35 | Noise cancelling LNA                          |
| 36 | Different configurations of differential LNA  |
| 37 | Power amplifier basics                        |
| 38 | Design of power amplifier                     |
| 39 | Single ended and differential power amplifier |
| 40 | High efficiency power amplifier               |
| 41 | Numericals on power amplifier                 |

|                                   |                                                                                                                                 |                       |                           |                                       |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                 | B Tech                | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                 | Low Power VLSI Design |                           |                                       |
| Course Code                       |                                                                                                                                 | ECE 453               |                           |                                       |
| Core / Elective / Other           |                                                                                                                                 | Elective              |                           |                                       |
| Prerequisite:                     |                                                                                                                                 |                       |                           |                                       |
| 1.                                | Linear Integrated Circuits                                                                                                      |                       |                           |                                       |
| 2.                                | VLSI Design EC                                                                                                                  |                       |                           |                                       |
| 3.                                |                                                                                                                                 |                       |                           |                                       |
| Course Outcomes:                  |                                                                                                                                 |                       |                           |                                       |
| 1.                                | Design levels (mainly circuit, transistor, and gate).                                                                           |                       |                           |                                       |
| 2.                                | Power optimization for combinational and sequential circuits                                                                    |                       |                           |                                       |
| 3.                                | Leakage power consumption in deep submicron technologies Power analysis and design at system level Case studies.                |                       |                           |                                       |
| Description of Contents in brief: |                                                                                                                                 |                       |                           |                                       |
| 1.                                | Modeling and sources of power consumption,                                                                                      |                       |                           |                                       |
| 2.                                | Power estimation at different design levels(mainly circuit, transistor, and gate) Power optimization for combinational circuits |                       |                           |                                       |
| 3.                                | Power optimization for sequential circuits Circuit                                                                              |                       |                           |                                       |
| 4.                                | Circuit Layout level for low power                                                                                              |                       |                           |                                       |
| 5.                                | Leakage power in deep sub-micron technologies Power analysis and design at system level. Case studies.                          |                       |                           |                                       |
| List of Text Books:               |                                                                                                                                 |                       |                           |                                       |
| 1.                                | Low Power CMOS VLSI Circuit Design Kaushik Roy, Sharat Prasad                                                                   |                       |                           |                                       |
| 2.                                | Practical Low Power Digital VLSI Design Gary Yeap                                                                               |                       |                           |                                       |
| 3.                                |                                                                                                                                 |                       |                           |                                       |
| List of Reference Books:          |                                                                                                                                 |                       |                           |                                       |
| 1.                                | Low Power Design in Deep Sub-micron Electronics W. Nebel and J. Mermet, Kluwer                                                  |                       |                           |                                       |
| 2.                                |                                                                                                                                 |                       |                           |                                       |
| 3.                                |                                                                                                                                 |                       |                           |                                       |
| URLs:                             |                                                                                                                                 |                       |                           |                                       |

**Lecture Plan (about 40-50 Lectures):**

| Lecture No. | Topic                                                           |
|-------------|-----------------------------------------------------------------|
| 1.          | Introduction to VLSI design and modern era of Tecnology scaling |
| 2.          | Effects and fundamental of technology scaling                   |

|     |                                                                                                      |
|-----|------------------------------------------------------------------------------------------------------|
| 3.  | Transistors in DSM technology, concepts and FinFets, etc                                             |
| 4.  | Introduction To low power Design                                                                     |
| 5.  | Sources of Power Consumption                                                                         |
| 6.  | Power Estimation: Probabilistic Technique for signal Activity estimation I                           |
| 7.  | Power Estimation: Probabilistic Technique for signal Activity estimation I                           |
| 8.  | Power Estimation: Probabilistic Technique for signal Activity estimation I                           |
| 9.  | Estimation of glitching Power                                                                        |
| 10. | Power dissipation in domino CMOS                                                                     |
| 11. | Power consumption of CMOS gates                                                                      |
| 12. | Leakage currents in DSM                                                                              |
| 13. | Leakage Power Consumption in deep submicron technologies.I                                           |
| 14. | Leakage Power Consumption in deep submicron technologies.II                                          |
| 15. | Tutorial I                                                                                           |
| 16. | Techniques for Leakage Power Reduction I                                                             |
| 17. | Techniques for Leakage Power Reduction II                                                            |
| 18. | Techniques for Leakage Power Reduction III                                                           |
| 19. | Techniques for Leakage Power Reduction IV                                                            |
| 20. | Techniques for Leakage Power Reduction V (Supply voltage scaling )& Self adjusting threshold scheme) |
| 21. | Techniques for Leakage Power Reduction for minimizing switched capacitance I                         |
| 22. | Techniques for Leakage Power Reduction for minimizing switched capacitance II                        |
| 23. | Techniques for Leakage Power Reduction for minimizing switched capacitance III                       |
| 24. | Techniques for Leakage Power Reduction for minimizing switched capacitance IV                        |
| 25. | Techniques for Leakage Power Reduction for minimizing switched capacitance V                         |
| 26. | Techniques for Leakage Power Reduction for minimizing switched capacitance VI                        |
| 27. | Techniques for Leakage Power Reduction for minimizing switched capacitance VII                       |
| 28. | Techniques for Leakage Power Reduction for minimizing switched capacitance VIII                      |
| 29. | Techniques for Leakage Power Reduction for minimizing switched capacitance IX                        |
| 30. | Techniques for Leakage Power Reduction for minimizing switched capacitance X                         |
| 31. | Tutorials                                                                                            |
| 32. | Leakage reduction techniques, process level and circuit level techniques                             |
| 33. | Design time leakage reduction technique                                                              |
| 34. | Design time leakage reduction technique                                                              |
| 35. | Run time standby leakage reduction techniques                                                        |
| 36. | Run time standby leakage reduction techniques                                                        |
| 37. | Run time standby leakage reduction techniques                                                        |
| 38. | Run time Active leakage reduction techniques                                                         |
| 39. | Run time Active leakage reduction techniques                                                         |
| 40. | Run time Active leakage reduction techniques                                                         |

|                                   |                                                                                                                                                                                |                           |                                       |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------|
| Name of Program                   | B-Tech                                                                                                                                                                         | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    | CAD of Digital Systems                                                                                                                                                         |                           |                                       |
| Course Code                       | ECE 454                                                                                                                                                                        |                           |                                       |
| Core / Elective / Other           | Elective                                                                                                                                                                       |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                |                           |                                       |
| 1.                                |                                                                                                                                                                                |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                |                           |                                       |
| 1.                                | Fundamentals of CAD tools for modelling, design, test and verification of VLSI systems.                                                                                        |                           |                                       |
| 2.                                | Study of various phases of CAD, including simulation, physical design, test and verification.                                                                                  |                           |                                       |
| 3.                                | Demonstrate knowledge of computational algorithms and tools for CAD.                                                                                                           |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                |                           |                                       |
| 1.                                | Introduction to VLSI Methodologies, Design domains and actions. Design methods and technologies. VLSI design automation tools                                                  |                           |                                       |
| 2.                                | Structural and transistor level design algorithmic and system design algorithmic graph theory and computational complexities                                                   |                           |                                       |
| 3.                                | Tractable and intractable problems, general purpose methods for combinational optimization, Layout compaction                                                                  |                           |                                       |
| 4.                                | Placement and partitioning, Floor planning concepts, Routing definition and Concept                                                                                            |                           |                                       |
| 5.                                | Simulation – general remarks on VLSI simulation, gate level modeling and simulation switchlevel modeling and simulation logic synthesis and verification, high level synthesis |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                |                           |                                       |
| 1.                                | S.H. Gerez, “Algorithms for VLSI Design Automation”, 1998                                                                                                                      |                           |                                       |
| 2.                                | N.A. Sherwani, “Algorithms for VLSI Physical Design Automation”, 1999                                                                                                          |                           |                                       |
| 3.                                | JA Bondy, USR Murty “Graph Theory With Applications” Elsevier Science Publishing Co. Inc , 1982                                                                                |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                                |                           |                                       |
| 1.                                | Giovanni De Micheli ,“Synthesis And Optimization Of Digital Circuits”.                                                                                                         |                           |                                       |
| 2.                                |                                                                                                                                                                                |                           |                                       |
| 3.                                |                                                                                                                                                                                |                           |                                       |
| URLs:                             |                                                                                                                                                                                |                           |                                       |
| 1.                                |                                                                                                                                                                                |                           |                                       |

**Lecture Plan (about 40-50 Lectures):**

| <b>Lecture No.</b> | <b>Topic</b>                                                          |
|--------------------|-----------------------------------------------------------------------|
| 1                  | Introduction and Review to VLSI Methodologies,                        |
| 2                  | VLSI Physical Design Automation                                       |
| 3                  | Design and Fabrication of VLSI Devices,                               |
| 4                  | Fabrication process and its impact on Physical Design                 |
| 5                  | VLSI design automation tools                                          |
| 6                  | Graph Theory Fundamentals.                                            |
| 7                  | Graph theory Definitions                                              |
| 8                  | More definitions and problems                                         |
| 9                  | Data structures and basic algorithms –                                |
| 10                 | Analysis of algorithms                                                |
| 11                 | Graph theory                                                          |
| 12                 | Computational complexity of Graph Theory                              |
| 13                 | Asymptotic Notations, Big O notation                                  |
| 14                 | Breadth first search                                                  |
| 15                 | Depth first search                                                    |
| 16                 | Maximum flow Algorithm                                                |
| 17                 | Some problems on Algorithms                                           |
| 18                 | Dijkstras Algorithm                                                   |
| 19                 | Prims algorithm                                                       |
| 20                 | Floyd Warshall Algorithm                                              |
| 21                 | Kruskal Algorithm                                                     |
| 22                 | Longest path Algorithm                                                |
| 23                 | Liao Wong Algorithm                                                   |
| 24                 | 4 queens problem and Travelling Salesman problem                      |
| 25                 | Bellman Ford Algorithm                                                |
| 26                 | Tractable and intractable problems.                                   |
| 27                 | Polynomial nonpolynomial algorithms                                   |
| 28                 | Optimization algorithms tarvelling salesman problem                   |
| 29                 | Dynamic programming                                                   |
| 30                 | Branch and bound concept and examples                                 |
| 31                 | Back tracking and all pair shortest path algorithm                    |
| 32                 | Definition of partitioning-floor planning and                         |
| 33                 | Pin assignment                                                        |
| 34                 | Placement algorithm                                                   |
| 35                 | Floorplanning Algorithms                                              |
| 36                 | Routing algorithm (LEE algorithm)                                     |
| 37                 | Simulation – logic synthesis                                          |
| 38                 | High level synthesis compaction                                       |
| 39                 | Physical design automation of FPGAs, MCMS                             |
| 40                 | VHDL-Verilog implementation of simple circuits using VHDL and Verilog |

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                           |                                       |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | B. Tech         | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Nano Technology |                           |                                       |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ECE 455         |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Elective        |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                           |                                       |
| 1.                                | The students are well versed with the fundamentals of Applied Electronics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                           |                                       |
| 2.                                | The students are well versed with the fundamentals of Microelectronics Circuits Design Practicum (MCDP).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                           |                                       |
| 3.                                | The students are well versed with the fundamentals of Electronics Devices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                           |                                       |
| 4.                                | The students are well versed with the fundamentals of Solid State Physics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                           |                                       |
| 1.                                | Students will understand the divers electronic device fabrication.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |                           |                                       |
| 2.                                | Students will be able to explain Nano Electronics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |                           |                                       |
| 3.                                | Students will be able to explain Nano –Microfabrication.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                           |                                       |
| 1.                                | Tunnel junction and applications of tunneling, Tunneling Through a Potential Barrier, Metal—Insulator, Metal-Semiconductor, and Metal-Insulator-Metal Junctions, Coulomb Blockade, Tunnel Junctions, Tunnel Junction Excited by a Current Source. Spintronics and Foundations of nano-photonics.                                                                                                                                                                                                                                                                                                                |                 |                           |                                       |
| 2.                                | Field Emission, Gate—Oxide Tunneling and Hot Electron Effects in nano MOSFETs, Theory of Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode.                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |                           |                                       |
| 3.                                | Introduction to lithography- Contact, proximity printing and Projection Printing, Resolution Enhancement techniques, overlay-accuracies, Mask-Error enhancement factor (MEEF), Positive and negative photoresists, Electron Lithography, Projection Printing, Direct writing, Electron resists. Lithography based on Surface Instabilities: Wetting, De-wetting, Adhesion, Limitations, Resolution and Achievable / line widths etc. Lift off process, Bulk Micro machining.                                                                                                                                    |                 |                           |                                       |
| 4.                                | Introduction to MEMS and NEMS, working principles, as micro sensors (acoustic wave sensor, biomedical and biosensor, chemical sensor, optical sensor, capacitive sensor, pressure sensor and thermal sensor), micro actuation (thermal actuation, piezoelectric actuation and electrostatic actuation—micro grippers, motors, valves, pumps, accelerometers, fluidics and capillary electrophoresis, active and passive micro fluidic devices, Pizoresistivity, Pizoelectricity and thermoelectricity, MEMS/NEMS design, processing, Oxidation, Sputter deposition, Evaporation, Chemical vapor deposition etc. |                 |                           |                                       |
| 5.                                | Introduction – Scaling of physical systems – Geometric scaling & Electrical system scaling. The Single-Electron Transistor: The Single- Electron Transistor Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs,Coulomb Blockade in a Nanocapacitor, Molecular SETs and Molecular Electronics.                                                                                                                                                                                                                    |                 |                           |                                       |

**List of Text Books:**

|    |                                                                                   |
|----|-----------------------------------------------------------------------------------|
| 1. | Stephen D. Sentaria, Microsystem Design, Kluwer Academic Press                    |
| 2. | Marc Madou, Fundamentals of microfabrication & Nanofabrication.                   |
| 3. | T. Fukada&W.Mens, Micro Mechanical system Principle & Technology, Elsevier, 1998. |

**List of Reference Books:**

|    |                                                                                                                 |
|----|-----------------------------------------------------------------------------------------------------------------|
| 1. | Julian W.Gardnes, Vijay K. Varda, Micro sensors MEMS & Smart Devices, 2001.                                     |
| 2. | Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer. |

**Lecture Plan (about 40-50 Lectures):**

| Lecture No. | Topic                                                                                                                                                                                                         |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.          | Tunnel junction and applications of tunneling.                                                                                                                                                                |
| 2.          | Tunneling Through a Potential Barrier.                                                                                                                                                                        |
| 3.          | Metal—Insulator, Metal-Semiconductor and Metal-Insulator-Metal Junctions.                                                                                                                                     |
| 4.          | Coulomb Blockade.                                                                                                                                                                                             |
| 5.          | Tunnel Junctions, Tunnel Junction Excited by a Current Source.                                                                                                                                                |
| 6.          | Spintronics.                                                                                                                                                                                                  |
| 7.          | Foundations of nano-photonics.                                                                                                                                                                                |
| 8.          | Field Emission.                                                                                                                                                                                               |
| 9.          | Gate—Oxide Tunneling.                                                                                                                                                                                         |
| 10.         | Hot Electron Effects in nano MOSFETs.                                                                                                                                                                         |
| 11.         | Theory of Scanning Tunneling Microscope.                                                                                                                                                                      |
| 12.         | Double Barrier Tunneling.                                                                                                                                                                                     |
| 13.         | Resonant Tunneling Diode.                                                                                                                                                                                     |
| 14.         | Introduction to lithography.                                                                                                                                                                                  |
| 15.         | Contact, proximity printing and Projection Printing.                                                                                                                                                          |
| 16.         | Resolution Enhancement techniques, overlay-accuracies.                                                                                                                                                        |
| 17.         | Mask-Error enhancement factor (MEEF).                                                                                                                                                                         |
| 18.         | Positive and negative photoresists.                                                                                                                                                                           |
| 19.         | Electron Lithography, Projection Printing.                                                                                                                                                                    |
| 20.         | Direct writing, Electron resists.                                                                                                                                                                             |
| 21.         | Litho.graphy based on Surface Instabilities                                                                                                                                                                   |
| 22.         | Wetting, De-wetting, Adhesion, Limitations                                                                                                                                                                    |
| 23.         | Resolution and Achievable / line widths etc.                                                                                                                                                                  |
| 24.         | Lift off process.                                                                                                                                                                                             |
| 25.         | Bulk Micro machining.                                                                                                                                                                                         |
| 26.         | Introduction to MEMS and NEMS, working principles, as micro sensors (acoustic wave sensor, biomedical and biosensor, chemical sensor, optical sensor, capacitive sensor, pressure sensor and thermal sensor). |
| 27.         | Micro actuation (thermal actuation, piezoelectric actuation and electrostatic)                                                                                                                                |
| 28.         | Actuation—micro grippers, motors, valves, pumps, accelerometers, fluidics and capillary electrophoresis.                                                                                                      |
| 29.         | Active and passive micro fluidic devices.                                                                                                                                                                     |
| 30.         | Pizoresistivity,Pizoelectricity and thermoelectricity.                                                                                                                                                        |

|     |                                                                                                  |
|-----|--------------------------------------------------------------------------------------------------|
| 31. | MEMS/NEMS design processing.                                                                     |
| 32. | Oxidation.                                                                                       |
| 33. | Sputter deposition                                                                               |
| 34. | Evaporation                                                                                      |
| 35. | Chemical vapor deposition etc                                                                    |
| 36. | Introduction – Scaling of physical systems – Geometric scaling & Electrical system scaling       |
| 37. | The Single-Electron Transistor: The Single- Electron Transistor Single-Electron Transistor Logic |
| 38. | Other SET and FET Structures.                                                                    |
| 39. | Carbon Nanotube Transistors (FETs and SETs).                                                     |
| 40. | Semiconductor Nanowire FETs and SETs.                                                            |
| 41. | Coulomb Blockade in a Nanocapacitor                                                              |
| 42. | Molecular SETs.                                                                                  |
| 43. | Molecular Electronics                                                                            |

|                                      |                                                                                                                                                                                                                       |                  |                        |                                       |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------|---------------------------------------|
| Name of Program                      |                                                                                                                                                                                                                       | BTech            | Semester V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                                                                                                                       | Embedded Systems |                        |                                       |
| Course Code                          |                                                                                                                                                                                                                       | ECE 456          |                        |                                       |
| Core / Elective / Other              |                                                                                                                                                                                                                       | Elective         |                        |                                       |
| Prerequisite:                        |                                                                                                                                                                                                                       |                  |                        |                                       |
| 1                                    | Programming with C                                                                                                                                                                                                    |                  |                        |                                       |
| 2                                    | Data Structures                                                                                                                                                                                                       |                  |                        |                                       |
| 3                                    | Microprocessors and Microcontrollers                                                                                                                                                                                  |                  |                        |                                       |
| Course Outcomes:                     |                                                                                                                                                                                                                       |                  |                        |                                       |
| 1                                    | Understanding of the Scope of Application and Hardware Software Co-Design of Embedded Systems                                                                                                                         |                  |                        |                                       |
| 2                                    | Identification of problems and their solutions in the software architectures for Embedded Systems                                                                                                                     |                  |                        |                                       |
| 3                                    | RTOS case study, IDE case study, Embedded System Program structure with example templates                                                                                                                             |                  |                        |                                       |
| Description of Contents in brief:    |                                                                                                                                                                                                                       |                  |                        |                                       |
| 1                                    | Embedded System Design Issues                                                                                                                                                                                         |                  |                        |                                       |
| 2                                    | Hardware Software Codesign                                                                                                                                                                                            |                  |                        |                                       |
| 3                                    | Case Study of Digital Camera Design                                                                                                                                                                                   |                  |                        |                                       |
| 4                                    | Software Architectures, RTOS                                                                                                                                                                                          |                  |                        |                                       |
| 5                                    | Design with specific RTOS and Microcontroller – Micrium, PIC                                                                                                                                                          |                  |                        |                                       |
| List of Text Books:                  |                                                                                                                                                                                                                       |                  |                        |                                       |
| 1                                    | System Design: A Unified Hardware/Software Introduction – by- Frank Vahid, Tony Givergis (John Wiley & Sons)                                                                                                          |                  |                        |                                       |
| 2                                    | An Embedded Software Primer – by - David Simon (Pearson)                                                                                                                                                              |                  |                        |                                       |
| 3                                    | Design with PIC Microcontroller – by - John B Peatman (Pearson)                                                                                                                                                       |                  |                        |                                       |
| List of Reference Books:             |                                                                                                                                                                                                                       |                  |                        |                                       |
| 1                                    | Specification and Design of Embedded Systems – by – Gajski, Vahid, Narayan, Gong (Pearson)                                                                                                                            |                  |                        |                                       |
| 2                                    | Real Time Concepts for Embedded Systems – by - Qing Li and Caroline Yao (CMP Books - Wind River Systems)                                                                                                              |                  |                        |                                       |
| URLs:                                |                                                                                                                                                                                                                       |                  |                        |                                       |
| 1                                    | <a href="https://www.cs.ccu.edu.tw/~pahsiung/courses/soc/notes/SoC_Design_Flow_Tools_Codesign_2005_notes.pdf">https://www.cs.ccu.edu.tw/~pahsiung/courses/soc/notes/SoC_Design_Flow_Tools_Codesign_2005_notes.pdf</a> |                  |                        |                                       |
| 2                                    | <a href="http://esd.cs.ucr.edu/toc.html#toc_ch7">esd.cs.ucr.edu/toc.html#toc_ch7</a>                                                                                                                                  |                  |                        |                                       |
| 3                                    | <a href="https://ptolemy.berkeley.edu/projects/embedded/research/hsc/">https://ptolemy.berkeley.edu/projects/embedded/research/hsc/</a>                                                                               |                  |                        |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                                                       |                  |                        |                                       |
| Lecture No.                          | Topic                                                                                                                                                                                                                 |                  |                        |                                       |
| 1.                                   | Introduction to Embedded Systems, Motivation for study – Application                                                                                                                                                  |                  |                        |                                       |

|        |                                                                                             |
|--------|---------------------------------------------------------------------------------------------|
|        | areas, Market Economy                                                                       |
| 2.     | Embedded System Design Issues, Domain knowledge required for all the aspects of the subject |
| 3      | Overview of Hardware Software Codesign                                                      |
| 4      | Codesign Flow chart discussion, Design Space Exploration                                    |
| 5      | Elevator controller example – Representations and implementations                           |
| 6      | Processor Technologies – Controller and Data path variations                                |
| 7      | IC Technologies                                                                             |
| 8      | Digital camera example – functionality block diagram                                        |
| 9, 10  | Digital camera example – Implementation alternatives                                        |
| 11     | Digital camera example – Implementation alternatives and Analysis                           |
| 12     | Computation models – Sequential program, FSMD – Elevator controller                         |
| 13     | Concurrency – HCFSM, PSM                                                                    |
| 14     | Data flow model, Concurrent process model                                                   |
| 15     | System Partitioning – Structural/Functional, Partitioning Issues                            |
| 16     | Partitioning algorithms – Random mapping, Hierarchical clustering                           |
| 17     | Group migration                                                                             |
| 18     | Ratio-cut                                                                                   |
| 19     | Simulated Annealing                                                                         |
| 20     | Genetic Evolution                                                                           |
| 21     | Design Quality Estimation                                                                   |
| 22     | Hardware Estimation Model                                                                   |
| 23     | Software Estimation Model                                                                   |
| 24     | Buses and Protocols                                                                         |
| 25     | RTOS – Features, Task structure, RTOS Data structure                                        |
| 26     | Shared data problem                                                                         |
| 27     | RTOS primitives – Semaphores and their usage                                                |
| 28     | RTOS primitives – Queues and their usage                                                    |
| 29     | RTOS calls (Micrium OS)                                                                     |
| 30     | RTOS memory management calls                                                                |
| 31     | Embedded Systems Development Tool Chain                                                     |
| 32, 33 | PIC microcontroller                                                                         |
| 34     | PIC instruction set                                                                         |
| 35     | PIC programming examples                                                                    |
| 36     | PIC program template                                                                        |
| 37     | PIC program – Blink Example                                                                 |
| 38     | PIC program – Table usage                                                                   |
| 39     | PIC Timer and Interrupt structure                                                           |
| 40     | PIC program – Interrupt usage                                                               |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                    |                                 |                           |                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------|---------------------------------------|
| Name of Program                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                    | B.Tech                          | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                    | Broadband Optical Communication |                           |                                       |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                    | ECE 457                         |                           |                                       |
| Core / Elective / Other                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                    | Elective                        |                           |                                       |
| Prerequisite:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                    |                                 |                           |                                       |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Optical Communication                                                                                                                                              |                                 |                           |                                       |
| Course Outcomes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                    |                                 |                           |                                       |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To get a basic understanding of Broadband communication Technologies                                                                                               |                                 |                           |                                       |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To get a profound understanding of protocols applied in optical networks i.e. SONET/ SDH, Metropolitan-Area Networks, Fiber-optic LAN architectures and protocols. |                                 |                           |                                       |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To get a profound understanding of optical Communication, switching methods and networking techniques and understanding basics of lasers and photo-detectors       |                                 |                           |                                       |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To get a basic understanding of optical components employed in optical networks, optical node design, Access network – its dynamics and architecture.              |                                 |                           |                                       |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Capable of analyzing & configuring optical networks for specific applications.                                                                                     |                                 |                           |                                       |
| Description of Contents in brief:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                    |                                 |                           |                                       |
| <p>Intd. to Broadband Communication Technologies &amp; various components employed: Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR. Optical sources - LEDs and Lasers, Photo-detectors – PIN &amp;APD.Optical link design - BER calculation WDM &amp; DWDM systems &amp; their Design topologies.</p> <p>Introduction to Optical Networks; SONET / SDH, IP-SONET-WDM, Metropolitan-Area Networks, Fiber-optic LAN architectures and protocols- ring, star and bus architectures, DQDB, FDDI; High speed bus protocols.</p> <p>WDM Networks - Light path Topology, Broadcast and Select Networks – Topologies for Broadcast Networks, Testbeds for Broadcast &amp; Select WDM; Wavelength Routing Architecture. The optical layer, Node Designs, Routing and wavelength assignment, Switch-based Optical networks; Optical Access Network Architectures, Future Access Networks, All Optical Networks</p> |                                                                                                                                                                    |                                 |                           |                                       |
| List of Text Books:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                    |                                 |                           |                                       |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Rajiv Ramaswamy and Kumar N. Sivarajan, “Optical Networks”, 2nd Edition, Morgan Kaufmann Publishers (Elsevier)                                                     |                                 |                           |                                       |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Fibre Optic communication, J. Keiser, McGraw-Hill, 5 <sup>th</sup> Ed.                                                                                             |                                 |                           |                                       |
| List of Reference Books:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                    |                                 |                           |                                       |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Fiber optic Communication Systems, G. Agrawal John Wiley and sons                                                                                                  |                                 |                           |                                       |
| Lecture Plan (about 40-50 Lectures): (Tentative)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                    |                                 |                           |                                       |
| Lecture No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Topic                                                                                                                                                              |                                 |                           |                                       |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Fundamentals of telecom systems                                                                                                                                    |                                 |                           |                                       |

|     |                                                         |
|-----|---------------------------------------------------------|
| 2.  | Principles of communication and signaling               |
| 3.  | Fundamentals of transmission                            |
| 4.  | Optical Fiber Modes & configurations.                   |
| 5.  | Types of Fibers : Single Mode & Multimode               |
| 6.  | Single Mode Fibers, Mode Field diameter, Propagation    |
| 7.  | Design of Single Mode Fibers                            |
| 8.  | Intd. to Fiber manufacturing                            |
| 9.  | Attenuation, Scattering & Bending losses, Absorbtion.   |
| 10. | Signal Distortion, Group Delay, Dispersion: Intermodal  |
| 11. | Signal Distortion, Group Delay, Dispersion: Intermodal  |
| 12. | Dispersion in Optical Fibers                            |
| 13. | Dispersion in Single Mode Fibers                        |
| 14. | WDM Systems, DWDM, Dispersion management                |
| 15. | WDM Systems, DWDM, Dispersion management                |
| 16. | Intd. to Optical Amplifiers, EDFA                       |
| 17. | Intd. to Optical Amplifiers, EDFA                       |
| 18. | Mathematical models for networks                        |
| 19. | Mathematical models for networks                        |
| 20. | Protocols, Architectures for Broadband Networks         |
| 21. | Protocols, Architectures for Broadband Networks         |
| 22. | Access and Hybrid Networks                              |
| 23. | All optical networks. SDH                               |
| 24. | All optical networks. SDH                               |
| 25. | SONET                                                   |
| 26. | Midterm                                                 |
| 27. | Fiber-optic LAN architectures and protocols             |
| 28. | Fiber-optic LAN architectures and protocols             |
| 29. | Ring,star and bus architectures                         |
| 30. | DQDB, FDDI; High speed bus protocols                    |
| 31. | RATO-net, WDM networks- LAMBDA-net                      |
| 32. | Coherent star, PASS-net, shuffle-net                    |
| 33. | Midterm                                                 |
| 34. | Photonic Switching                                      |
| 35. | Photonic Switching                                      |
| 36. | Switching architectures single and multistage switching |
| 37. | Switching architectures single and multistage switching |
| 38. | Space switching, time switching                         |
| 39. | Space switching, time switching                         |
| 40. | Combinations of space and time switching                |
| 41. | SEED arrays WDM Network design                          |
| 42. | SEED arrays WDM Network design                          |
| 43. | Lightpath Topology                                      |
| 44. | Optical Line Terminal                                   |
| 45. | Optical Add / Drop multiplexers                         |
| 46. | Optical Cross connects and Wavelength conversion        |
| 47. | Optical Cross connects and Wavelength conversion        |

|                                   |                                                                                                                                                                                                                                                                                                                                            |                        |                           |                                       |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                            | B.Tech.                | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                            | Wireless Communication |                           |                                       |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                            | ECE 458                |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                            | Elective               |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                            |                        |                           |                                       |
| 1.                                | Analog Communication                                                                                                                                                                                                                                                                                                                       |                        |                           |                                       |
| 2.                                | Digital Communication                                                                                                                                                                                                                                                                                                                      |                        |                           |                                       |
| 3.                                | Signal Processing                                                                                                                                                                                                                                                                                                                          |                        |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                            |                        |                           |                                       |
| 1.                                | Understanding fading and multipath fading, types of fading channels                                                                                                                                                                                                                                                                        |                        |                           |                                       |
| 2.                                | learning mitigation techniques to remove impact of fading.                                                                                                                                                                                                                                                                                 |                        |                           |                                       |
| 3.                                | learning basics of the infrastructure less network (Adhoc network)                                                                                                                                                                                                                                                                         |                        |                           |                                       |
| 4.                                | Understanding more efficient frequency spectrum utilization technique Cognitive Radio Communication.                                                                                                                                                                                                                                       |                        |                           |                                       |
| 5.                                | Capable to analyse and understand various types of wireless communication standards.                                                                                                                                                                                                                                                       |                        |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                            |                        |                           |                                       |
| 1.                                | Wireless channels: Orthogonal Frequency Division Multiplexing (OFDM), OFDMA, Fading and fading channel models- AWGN, Rayleigh, Rician, Nakagami,                                                                                                                                                                                           |                        |                           |                                       |
| 2.                                | Multiple Input and Multiple Output (MIMO), millimetre waves. Interleave and De-Interleaver, Equalizer, Forward correction codes, Linear block code, Convolutional coding and decoding, Turbo coding and decoding, Viterbi algorithm.                                                                                                       |                        |                           |                                       |
| 3.                                | Mobile AdhocNetwork(MANet) : Infrastructure less network, Medium access Protocols for MANet, Routing Protocols, Wireless Sensor Networks: Distributed Sensing Nodes, Power saving medium access protocols, IEEE 808.15.4.                                                                                                                  |                        |                           |                                       |
| 4.                                | Cognitive Radio Network (CRN): Spectrum Sensing Techniques: Energy Detector, Cyclostationary Detector, Matched Filter Detector, Radio Identification Detector, Cyclo-Energy Detector etc. Cooperative spectrum Sensing: Data and Decision cooperative spectrum sensing, Fusion Center, Spectrum Allocation Techniques, IEEE 802.22 (WRAN). |                        |                           |                                       |
| 5.                                | Wireless Access Networks: WLAN, IEEE 802.11, WiMAX, IEEE 802.16, LTE, Ultra Wide-Band (UWB).                                                                                                                                                                                                                                               |                        |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                            |                        |                           |                                       |
| 1.                                | “Wireless Communications:Principles and Practice”, by T.S. Rappaport, Prentice Hall publication.                                                                                                                                                                                                                                           |                        |                           |                                       |
| 2.                                | Ad Hoc Networking”, by Perkins, Pearson publication, 2008 Edition                                                                                                                                                                                                                                                                          |                        |                           |                                       |
| 3.                                | “A survey of spectrum sensing algorithms for cognitive radio Applications”, TefvikYucek, HuseyinArslan, IEEE communications survey & tutorials, vol. 11, no. 1, 2009, pp. 116-129.                                                                                                                                                         |                        |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                                                                                                                                                                                            |                        |                           |                                       |

|    |                                                                                                                                                                                        |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | “Introduction to Wireless and Mobile Systems”, by <a href="#">Dharma PrakashAgrawal</a> , <a href="#">Qing-An Zeng</a> , Cengage Learning publication.                                 |
| 2. | “Ad Hoc Mobile Wireless Networks”, by Sudhir K. Sarkar, T.G. Basavraju, C. Puttamadappa, CRC publication                                                                               |
| 3. | “Cyclo-energy detector for spectrum sensing in cognitive radio”, Lei Yang, Zhe Chen, Fuliang Yin, International Journal of Electronics and Communications (AEÜ), 66 (2012), pp. 89-92. |
| 4. | “Wireless and Cellular Communications”, by William C.Y. Lee, McGRAW-HILL Publication.                                                                                                  |

#### URLs:

|    |                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------|
| 1. | <a href="https://nptel.ac.in/courses/117104099/">https://nptel.ac.in/courses/117104099/</a>                 |
| 2. | <a href="https://nptel.ac.in/courses/106/106/106106167/">https://nptel.ac.in/courses/106/106/106106167/</a> |

#### Lecture Plan (about 40-50 Lectures):

| Lecture No. | Topic                                                             |
|-------------|-------------------------------------------------------------------|
| 1.          | Orthogonal Frequency Division Multiplexing (OFDM)                 |
| 2.          | OFDMA                                                             |
| 3.          | Fading                                                            |
| 4.          | fading channel models- AWGN                                       |
| 5.          | Rayleigh                                                          |
| 6.          | Rician                                                            |
| 7.          | Nakagami                                                          |
| 8.          | AWGN, Rayleigh for BPSK                                           |
| 9.          | Multiple Input and Multiple Output (MIMO),                        |
| 10.         | millimetre waves.                                                 |
| 11.         | Interleave and De-Interleaver,                                    |
| 12.         | Equalizer,                                                        |
| 13.         | Forward correction codes, Linear block code,                      |
| 14.         | Convolutional coding and decoding,                                |
| 15.         | Turbo coding and decoding,.                                       |
| 16.         | Viterbi algorithm                                                 |
| 17.         | <b>Mobile Adhoc Network(MANet)</b> : Infrastructure less network  |
| 18.         | Medium access Protocols for MANet                                 |
| 19.         | Medium access Protocols for MANet continued                       |
| 20.         | Routing Protocols                                                 |
| 21.         | Wireless Sensor Networks                                          |
| 22.         | Distributed Sensing Nodes,                                        |
| 23.         | Power saving medium access protocols,                             |
| 24.         | IEEE 808.15.4.                                                    |
| 25.         | <b>Cognitive Radio Network (CRN):</b> Spectrum Sensing Techniques |
| 26.         | Energy Detector                                                   |
| 27.         | Cyclostationary Detector                                          |
| 28.         | Matched Filter Detector                                           |
| 29.         | Radio Identification Detector                                     |
| 30.         | Cyclo-Energy Detector                                             |

|     |                                                                                        |
|-----|----------------------------------------------------------------------------------------|
| 31. | Cooperative spectrum Sensing: Data and Decision cooperative spectrum sensing           |
| 32. | Cooperative spectrum Sensing: Data and Decision cooperative spectrum sensing continued |
| 33. | Fusion Center                                                                          |
| 34. | Spectrum Allocation Techniques                                                         |
| 35. | IEEE 802.22 (WRAN).                                                                    |
| 36. | <b>Wireless Access Networks: WLAN</b>                                                  |
| 37. | IEEE 802.11                                                                            |
| 38. | WiMAX                                                                                  |
| 39. | IEEE 802.16, LTE                                                                       |
| 40. | Ultra Wide-Band (UWB)                                                                  |

|                                   |                                                                                                                |                                         |                           |                                       |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                | BTech                                   | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                | Computer Vision and Pattern Recognition |                           |                                       |
| Course Code                       |                                                                                                                | ECE 459                                 |                           |                                       |
| Core / Elective / Other           |                                                                                                                | Elective                                |                           |                                       |
| Prerequisite:                     |                                                                                                                |                                         |                           |                                       |
| 1.                                | Digital Image Processing                                                                                       |                                         |                           |                                       |
| Course Outcomes:                  |                                                                                                                |                                         |                           |                                       |
| 1.                                | Introduce students to the major ideas, methods, and techniques of Computer Vision and image classification.    |                                         |                           |                                       |
| 2.                                | To demonstrate the fundamentals and techniques of pattern recognition and detection.                           |                                         |                           |                                       |
| 3.                                | To make students familiar with various issues in the design of pattern recognition and classification systems. |                                         |                           |                                       |
| 4.                                | Students will be able to select and extract the appropriate features form images of diverse application.       |                                         |                           |                                       |
| 5.                                | Students will be able to develop domain specific classification models.                                        |                                         |                           |                                       |
| Description of Contents in brief: |                                                                                                                |                                         |                           |                                       |
| 1.                                | Image Formation and Imaging Systems                                                                            |                                         |                           |                                       |
| 2.                                | Image Processing                                                                                               |                                         |                           |                                       |
| 3.                                | Pattern Recognition                                                                                            |                                         |                           |                                       |
| 4.                                | Fearure Selection                                                                                              |                                         |                           |                                       |
| 5.                                | Classification Models                                                                                          |                                         |                           |                                       |
| 6.                                | Artificial Neural Networks                                                                                     |                                         |                           |                                       |
| List of Text Books:               |                                                                                                                |                                         |                           |                                       |
| 1.                                | Pattern Classification by Duda, Hart, and Stork, 2nd edition, John Wiley Interscience, 2012.                   |                                         |                           |                                       |
| 2.                                | Computer Vision: A Modern Approach, D.A. Forsyth and J. Ponce, Prentice-Hall, 2015.                            |                                         |                           |                                       |
| List of Reference Books:          |                                                                                                                |                                         |                           |                                       |
| 1.                                | The Elements of Statistical Learning T. Hastie et al., Springer-Verlag, 2013.                                  |                                         |                           |                                       |
| 2.                                | Machine Learning: A probabilistic Perspective K. Murphy, MIT Press, 2012.                                      |                                         |                           |                                       |
| 3.                                | Computer Vision, L.G. Shapiro and G. Stockman, Prentice-Hall, 2001.                                            |                                         |                           |                                       |
| 4.                                | Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Pearson, 2015.    |                                         |                           |                                       |
| URLs:                             |                                                                                                                |                                         |                           |                                       |
| 1.                                |                                                                                                                |                                         |                           |                                       |
| 2.                                |                                                                                                                |                                         |                           |                                       |

**Lecture Plan (about 40-50 Lectures):**

| <b>Lecture No.</b> | <b>Topic</b>                               |
|--------------------|--------------------------------------------|
| 1.                 | Review of Digital Image Processing         |
| 2.                 | Image Formation                            |
| 3.                 | Image Models I                             |
| 4.                 | Image Models I                             |
| 5.                 | Radiometry                                 |
| 6.                 | Shadows and Shading                        |
| 7.                 | Color Cameras                              |
| 8.                 | Segmentation and Fitting                   |
| 9.                 | Tracking with Linear Dynamic Models I      |
| 10.                | Tracking with Linear Dynamic Models II     |
| 11.                | Correspondence and Pose                    |
| 12.                | Registration in Imaging Systems I          |
| 13.                | Registration in Imaging Systems II         |
| 14.                | Pattern Definition                         |
| 15.                | Types of Pattern                           |
| 16.                | Pattern Recognition System                 |
| 17.                | Components of Pattern Recognition System   |
| 18.                | Bayesian Decision Theory                   |
| 19.                | Bayesian Networks                          |
| 20.                | Bayesian Estimation                        |
| 21.                | Bayes Error                                |
| 22.                | Maximum Likelihood Estimation I            |
| 23.                | Maximum Likelihood Estimation II           |
| 24.                | Dimensionality Reduction                   |
| 25.                | Feature Selection                          |
| 26.                | Linear Discriminant Functions              |
| 27.                | Nearest Neighbour based Classifiers I      |
| 28.                | Nearest Neighbour based Classifiers II     |
| 29.                | Decision Tree Based Classifiers I          |
| 30.                | Decision Tree Based Classifiers II         |
| 31.                | Support Vector Machines (SVMs) I           |
| 32.                | Support Vector Machines (SVMs) II          |
| 33.                | Expectation-Maximization (EM) Algorithm I  |
| 34.                | Expectation-Maximization (EM) Algorithm II |
| 35.                | Non-parametric Estimation I                |
| 36.                | Non-parametric Estimation II               |
| 37.                | Class Histograms                           |
| 38.                | Classifier Building                        |
| 39.                | Artificial Neural Networks I               |
| 40.                | Artificial Neural Networks II              |

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|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------|---------------------------------------|
| Name of Program                      |                                                                                                                                                                                           | B.Tech               | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                                                                                           | Mobile Communication |                           |                                       |
| Course Code                          |                                                                                                                                                                                           | ECE 460              |                           |                                       |
| Core / Elective / Other              |                                                                                                                                                                                           | Elective             |                           |                                       |
| Prerequisite:                        |                                                                                                                                                                                           |                      |                           |                                       |
| 1.                                   | Antenna and Microwave Engineering                                                                                                                                                         |                      |                           |                                       |
| 2.                                   | Concept of communication Engineering                                                                                                                                                      |                      |                           |                                       |
| 3.                                   | Network Theorems and Algorithms.                                                                                                                                                          |                      |                           |                                       |
| Course Outcomes:                     |                                                                                                                                                                                           |                      |                           |                                       |
| 1.                                   | CO1: Explain the different types of mobile communication network model.                                                                                                                   |                      |                           |                                       |
| 2.                                   | CO2: Classify the channel assignment and frequency reuse concept for mobile communications.                                                                                               |                      |                           |                                       |
| 3.                                   | CO3: Analyze different routing algorithms and methods to improve QOS.                                                                                                                     |                      |                           |                                       |
| 4.                                   | CO4: Summarize the attenuation of wave propagation.                                                                                                                                       |                      |                           |                                       |
| 5.                                   | CO5: Describe various application of GSM Technology 3G ,4G, 5G etc.                                                                                                                       |                      |                           |                                       |
| Description of Contents in brief:    |                                                                                                                                                                                           |                      |                           |                                       |
| 1.                                   | Concepts of cellular communication, System design fundamentals,                                                                                                                           |                      |                           |                                       |
| 2.                                   | Geometry of hexagonal cells                                                                                                                                                               |                      |                           |                                       |
| 3.                                   | Co-channel interference, Cell splitting, Frequency allocation in mobile, Handoff<br>Frequency Reuse                                                                                       |                      |                           |                                       |
| 4.                                   | Mobile radio wave propagation; reflection, diffraction, fading. Path loss prediction.<br>Multipath propagation.                                                                           |                      |                           |                                       |
| 5.                                   | Statistical characterization of multipath fading. Diversity .Link design. Design<br>parameters for base station.                                                                          |                      |                           |                                       |
| 6.                                   | Antenna location, spacing, heights and configurations. Multiple access techniques;<br>FDMA, TDMA and CDMA. Spread spectrum.                                                               |                      |                           |                                       |
| 7.                                   | Power control. WCDMA. CDMA network design. GSM. 3G systems. WLAN<br>technology. WLL. Hiper LAN. Ad hoc networks. Bluetooth. OFDM and MC-CDMA,<br>Wi-MAX, LTE, Study on radiation hazards. |                      |                           |                                       |
| List of Text Books:                  |                                                                                                                                                                                           |                      |                           |                                       |
| 1.                                   | Wireless Communication Principles T.S.Rappaport                                                                                                                                           |                      |                           |                                       |
| 2.                                   | Mobile Communication Engineering W.C.Y.Lee,                                                                                                                                               |                      |                           |                                       |
| 3.                                   | Wireless Communications A.F.Molisch                                                                                                                                                       |                      |                           |                                       |
| List of Reference Books:             |                                                                                                                                                                                           |                      |                           |                                       |
| 1.                                   | Principles of Mobile Communications G.L. Stuber                                                                                                                                           |                      |                           |                                       |
| 2.                                   | Wireless Communications Andrea Golsmith                                                                                                                                                   |                      |                           |                                       |
| URLs:                                |                                                                                                                                                                                           |                      |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                           |                      |                           |                                       |
| Lecture No.                          | Topic                                                                                                                                                                                     |                      |                           |                                       |

|    |                                                                                                   |
|----|---------------------------------------------------------------------------------------------------|
| 1. | Concepts of cellular communication                                                                |
| 2. | -----do-----                                                                                      |
| 3  | -----do-----                                                                                      |
| 4  | -----do-----                                                                                      |
| 5  | System design fundamentals,                                                                       |
| 6  | -----do-----                                                                                      |
| 7  | -----do-----                                                                                      |
| 8  | Geometry of hexagonal cells                                                                       |
| 9  | -----do-----                                                                                      |
| 10 | -----do-----                                                                                      |
| 11 | Co-channel interference, Cell splitting                                                           |
| 12 | -----do-----                                                                                      |
| 13 | Cell splitting, Frequency allocation in mobile,                                                   |
| 14 | -----do-----                                                                                      |
| 15 | -----do-----                                                                                      |
| 16 | Handoff Frequency Reuse                                                                           |
| 17 | -----do-----                                                                                      |
| 18 | -----do-----                                                                                      |
| 19 | Mobile radio wave propagation; reflection, diffraction, fading                                    |
| 20 | -----do-----                                                                                      |
| 21 | -----do-----                                                                                      |
| 22 | Path loss prediction. Multipath propagation.                                                      |
| 23 | -----do-----                                                                                      |
| 24 | -----do-----                                                                                      |
| 25 | Statistical characterization of multipath fading. Diversity .Link design                          |
| 26 | -----do-----                                                                                      |
| 27 | -----do-----                                                                                      |
| 28 | Design parameters for base station.                                                               |
| 29 | -----do-----                                                                                      |
| 30 | -----do-----                                                                                      |
| 31 | Antenna location, spacing, heights and configurations                                             |
| 32 | -----do-----                                                                                      |
| 33 | -----do-----                                                                                      |
| 34 | Multiple access techniques; FDMA, TDMA and CDMA. Spread spectrum.                                 |
| 34 | -----do-----                                                                                      |
| 36 | -----do-----                                                                                      |
| 37 | -----do-----                                                                                      |
| 38 | Power control. WCDMA. CDMA network design                                                         |
| 39 | -----do-----                                                                                      |
| 40 | -----do-----                                                                                      |
| 41 | GSM. 3G systems. WLAN technology. WLL.                                                            |
| 42 | -----do-----                                                                                      |
| 43 | Hiper LAN. Ad hoc networks. Bluetooth. OFDM and MC-CDMA, Wi-MAX, LTE, Study on radiation hazards. |
| 44 | -----do-----                                                                                      |
| 45 | -----do-----                                                                                      |

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|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                                                        | B. Tech.                     | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                                                        | Radar and Navigation Systems |                           |                                       |
| Course Code                       |                                                                                                                                                                                                        | ECE 461                      |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                                                        | Elective                     |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                        |                              |                           |                                       |
| 1.                                | Fundamental knowledge of electronics, electromagnetic                                                                                                                                                  |                              |                           |                                       |
| 2.                                | Antenna and wave propagation                                                                                                                                                                           |                              |                           |                                       |
| 3.                                | Analog Communication                                                                                                                                                                                   |                              |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                        |                              |                           |                                       |
| 1.                                | basic radar system and its range performance                                                                                                                                                           |                              |                           |                                       |
| 2.                                | Describe MTI and other radar system.                                                                                                                                                                   |                              |                           |                                       |
| 3.                                | Explain about various types of advanced navigation systems                                                                                                                                             |                              |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                        |                              |                           |                                       |
| 1.                                | The simple form of Radar Equation, Radar Block diagram and Operation, Radar Frequencies, millimetre and submillimetre waves, Applications of Radar.                                                    |                              |                           |                                       |
| 2.                                | Introduction, Delay line Cancellers, Multiple or staggered Pulse Repetition Frequencies, Range gated Doppler Filters,                                                                                  |                              |                           |                                       |
| 3.                                | Example of MTI radar Processor, , Pulse Doppler Radar, Non coherent MTI ,MTI from moving platform, Other types of MTI                                                                                  |                              |                           |                                       |
| 4.                                | Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, Track stabilization                                                                                                 |                              |                           |                                       |
| 5.                                | Doppler navigation system , GPS principle of operation, Position location determination                                                                                                                |                              |                           |                                       |
| 6.                                | Radar Transmitters and Receivers, Receiver noise Figure, Radar Displays. Radio Direction Finder, An Aural Null Direction Finder, The Goniometer, Adcock Direction finder, Errors in Direction Finding. |                              |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                        |                              |                           |                                       |
| 1.                                | Skolnik, M., "Introduction to Radar Systems", Tata McGraw-Hill                                                                                                                                         |                              |                           |                                       |
| 2.                                | N.S.Nagaraja, "Elements of Electronic Navigation Systems", Tata McGraw-Hill                                                                                                                            |                              |                           |                                       |
| 3.                                | G S N Raju , "Radar Engineering and Fundamentals of Navigational Aids" IK International Publishers,                                                                                                    |                              |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                                                        |                              |                           |                                       |
| 1.                                | Peyton Z. Peebles:, "Radar Principles", John Wiley                                                                                                                                                     |                              |                           |                                       |
| 2.                                | J.C Toomay, " Principles of Radar", 2nd Edition –PHI                                                                                                                                                   |                              |                           |                                       |
| 3.                                | Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGrawHill Book Company, New York                                                                                    |                              |                           |                                       |
| URLs:                             |                                                                                                                                                                                                        |                              |                           |                                       |
| 1.                                | <a href="http://nptel.iitm.ac.in/courses.php?branch=Ece">http://nptel.iitm.ac.in/courses.php?branch=Ece</a>                                                                                            |                              |                           |                                       |
| 2.                                | <a href="http://www.radartutorial.eu/07.waves/wa04.en.html">http://www.radartutorial.eu/07.waves/wa04.en.html</a>                                                                                      |                              |                           |                                       |

| 3.                                          | <a href="https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems">https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems</a> |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                             |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                |
| 1                                           | Introduction to Radar, Radar Equation                                                                                                                       |
| 2                                           | Radar Block Diagram, Radar Frequencies, Applications of Radar. Integration of Radar Pulses                                                                  |
| 3                                           | Radar Cross Section of Targets, Transmitter Power                                                                                                           |
| 4                                           | Pulse Repetition Frequency                                                                                                                                  |
| 5                                           | Radar system losses                                                                                                                                         |
| 6                                           | Introduction to Doppler and MTI Radar                                                                                                                       |
| 7                                           | Delay Line Cancellers                                                                                                                                       |
| 8                                           | Staggered Pulse Repetition                                                                                                                                  |
| 9                                           | Frequencies, Doppler Filter Banks                                                                                                                           |
| 10                                          | Digital MTI Processing                                                                                                                                      |
| 11                                          | Moving Target Detector                                                                                                                                      |
| 12                                          | Limitations to MTI Performance                                                                                                                              |
| 13                                          | MTI from a Moving Platform (AMIT) – Pulse Doppler Radar                                                                                                     |
| 14                                          | Tracking with Radar – Monopulse Tracking                                                                                                                    |
| 15                                          | Conical Scan and Sequential Lobing                                                                                                                          |
| 16                                          | Limitations to Tracking Accuracy                                                                                                                            |
| 17                                          | Low-Angle Tracking                                                                                                                                          |
| 18                                          | Tracking Range                                                                                                                                              |
| 19                                          | Comparison of Trackers                                                                                                                                      |
| 20                                          | Automatic Tracking with Surveillance Radars (ADT).                                                                                                          |
| 21                                          | The Radar Antenna                                                                                                                                           |
| 22                                          | Reflector Antennas                                                                                                                                          |
| 23                                          | Electronically Steered Phased Array Antennas                                                                                                                |
| 24                                          | Phase Shifters                                                                                                                                              |
| 25                                          | Frequency-Scan Arrays.                                                                                                                                      |
| 26                                          | Radar Transmitters and Receivers                                                                                                                            |

|    |                                                     |
|----|-----------------------------------------------------|
| 27 | Receiver noise Figure                               |
| 28 | RadarDisplays.                                      |
| 29 | Radio Direction Finder                              |
| 30 | An Aural Null Direction Finder                      |
| 31 | The Goniometer                                      |
| 32 | Adcock Direction finder                             |
| 33 | Hyperbolic Systems of Navigation (Loran and Decca), |
| 34 | Hyperbolic Systems of Navigation Decca              |
| 35 | Loran-A ,Loran-A Equipment                          |
| 36 | Range and precision of Standard Loran, Loran-C      |
| 37 | The Decca Navigation System Decca Receivers         |
| 38 | Range and Accuracy of Decca                         |
| 39 | DME and TACAN – Distance Measuring Equipment        |
| 40 | Operation of DME – TACAN Equipments                 |
| 41 | Satellite Navigation System                         |
| 42 | NavstarGlobal Positioning System (GPS)              |

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|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                          | B.Tech                  | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                          | Video Signal Processing |                           |                                       |
| Course Code                       |                                                                                                                                                                          | ECE 462                 |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                          | Elective                |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                          |                         |                           |                                       |
| 1.                                | Higher engineering mathematics                                                                                                                                           |                         |                           |                                       |
| 2.                                | Fundamental knowledge of signal processing                                                                                                                               |                         |                           |                                       |
| 3.                                | Fourier analysis (all signal processing relates to Fourier analysis in some form or another)                                                                             |                         |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                          |                         |                           |                                       |
| 1.                                | learn the basic principles and tools used to process videos, and how to apply them in solving practical problems of commercial and scientific interests.                 |                         |                           |                                       |
| 2.                                | Understand different methods, models for video processing and motion estimation.                                                                                         |                         |                           |                                       |
| 3.                                | Apply quantitative models of image and video processing for various engineering applications and develop innovative design for practical applications in various fields. |                         |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                          |                         |                           |                                       |
| 1.                                | Basics of Video, Analog Video signal, Composite video signal, Video Formation, Horizontal and vertical synchronization, Spatial and Temporal resolution                  |                         |                           |                                       |
| 2.                                | Video signal standards: NTSC, SECAM, PAL, Video signal BW requirement, Digital Video Processing, Analysis and synthesis of Video Signal,                                 |                         |                           |                                       |
| 3.                                | Colour Signal Generation and coding, Video display, Video camera, Video Coding                                                                                           |                         |                           |                                       |
| 4.                                | Motion Analysis and Motion Compensation, Motion compensated filtering, Motion Estimation techniques                                                                      |                         |                           |                                       |
| 5.                                | Optical flow methods, Block based methods, Bayesian method, Video Coding standards,                                                                                      |                         |                           |                                       |
| 6.                                | Video compression standards: H2.61, MPEG 1, MPEG 2                                                                                                                       |                         |                           |                                       |
| List of Text Books:               |                                                                                                                                                                          |                         |                           |                                       |
| 1.                                | M. Parker, s. Dhanani “Digital Video Processing for Engineers: A Foundation for Embedded Systems Design”, Newnes                                                         |                         |                           |                                       |
| 2.                                | Vijay Madisetti “Video, Speech, and Audio Signal Processing and Associated Standards” 1st Edition CRC press.                                                             |                         |                           |                                       |
| 3.                                | King N. Ngan, Chi W. Yap, Keng T. Tan “Video Coding for Wireless Communication Systems” CRC press                                                                        |                         |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                          |                         |                           |                                       |
| 1.                                | A M Tekalp, “Digital Video Processing”, PH Publication.                                                                                                                  |                         |                           |                                       |
| 2.                                | Y Q. Shi, H Sun, “Image and Video Compression for Multimedia Engineering”, CRC Press.                                                                                    |                         |                           |                                       |
| 3.                                | J W Woods, “Multi-Dimensional, Signal, Image and Video Processing and Coding” Academic Press.                                                                            |                         |                           |                                       |
| URLs:                             |                                                                                                                                                                          |                         |                           |                                       |
| 1.                                | <a href="https://www.oreilly.com/library/view/digital-video-processing/9780133991116/">https://www.oreilly.com/library/view/digital-video-processing/9780133991116/</a>  |                         |                           |                                       |

| 2.                                          | <a href="https://www.crcpress.com/Image-and-Video-Compression-for-Multimedia-Engineering-Fundamentals-Algorithms/Shi-Sun/p/book/9780849373640">https://www.crcpress.com/Image-and-Video-Compression-for-Multimedia-Engineering-Fundamentals-Algorithms/Shi-Sun/p/book/9780849373640</a> |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.                                          | <a href="https://www.elsevier.com/books/multidimensional-signal-image-and-video-processing-and-coding/woods/978-0-12-381420-3">https://www.elsevier.com/books/multidimensional-signal-image-and-video-processing-and-coding/woods/978-0-12-381420-3</a>                                 |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                                                                                                         |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                                                                                                                                            |
| 1.                                          | Basics of Video                                                                                                                                                                                                                                                                         |
| 2.                                          | Analog Video signal                                                                                                                                                                                                                                                                     |
| 3.                                          | Composite video signal                                                                                                                                                                                                                                                                  |
| 4.                                          | Video Formation                                                                                                                                                                                                                                                                         |
| 5.                                          | Horizontal synchronization                                                                                                                                                                                                                                                              |
| 6.                                          | Vertical synchronization                                                                                                                                                                                                                                                                |
| 7.                                          | Spatial resolution                                                                                                                                                                                                                                                                      |
| 8.                                          | Temporal resolution                                                                                                                                                                                                                                                                     |
| 9.                                          | Video signal standards                                                                                                                                                                                                                                                                  |
| 10.                                         | NTSC                                                                                                                                                                                                                                                                                    |
| 11.                                         | SECAM                                                                                                                                                                                                                                                                                   |
| 12.                                         | PAL                                                                                                                                                                                                                                                                                     |
| 13.                                         | Video signal BW requirement                                                                                                                                                                                                                                                             |
| 14.                                         | Digital Video Processing                                                                                                                                                                                                                                                                |
| 15.                                         | Analysis and synthesis of Video Signal                                                                                                                                                                                                                                                  |
| 16.                                         | Colour Signal Generation and coding                                                                                                                                                                                                                                                     |
| 17.                                         | Digital Video Signals and Formats                                                                                                                                                                                                                                                       |
| 18.                                         | Video Compression Techniques: Entropy and Predictive coding                                                                                                                                                                                                                             |
| 19.                                         | Block Transform Coding                                                                                                                                                                                                                                                                  |
| 20.                                         | Quantization                                                                                                                                                                                                                                                                            |
| 21.                                         | MC and Estimation Transform Coding                                                                                                                                                                                                                                                      |
| 22.                                         | Video display                                                                                                                                                                                                                                                                           |
| 23.                                         | Video camera                                                                                                                                                                                                                                                                            |
| 24.                                         | Video Coding                                                                                                                                                                                                                                                                            |
| 25.                                         | Motion Analysis                                                                                                                                                                                                                                                                         |
| 26.                                         | Notation and Preliminaries: Binary Hypothesis Testing                                                                                                                                                                                                                                   |
| 27.                                         | Markov Random Fields                                                                                                                                                                                                                                                                    |
| 28.                                         | MAP Estimation and Variational Formulation                                                                                                                                                                                                                                              |
| 29.                                         | Motion Detection: Hypothesis Testing with Fixed and Adaptive Threshold                                                                                                                                                                                                                  |
| 30.                                         | MAP MRF Formulation                                                                                                                                                                                                                                                                     |
| 31.                                         | MAP Variation Formulation                                                                                                                                                                                                                                                               |
| 32.                                         | Experimental Comparison of Motion Detection Methods 6 15 Motion Estimation                                                                                                                                                                                                              |
| 33.                                         | Motion Models and Estimation Criteria                                                                                                                                                                                                                                                   |
| 34.                                         | Search Strategies Practical Motion Estimation Algorithms                                                                                                                                                                                                                                |
| 35.                                         | Global Motion Estimation                                                                                                                                                                                                                                                                |
| 36.                                         | Block Matching and Phase Correlation                                                                                                                                                                                                                                                    |
| 37.                                         | Optical Flow via Regularization                                                                                                                                                                                                                                                         |
| 38.                                         | MAP Estimation of Dense Motion                                                                                                                                                                                                                                                          |
| 39.                                         | Motion Compensation                                                                                                                                                                                                                                                                     |
| 40.                                         | Motion compensated filtering                                                                                                                                                                                                                                                            |
| 41.                                         | Motion Estimation techniques                                                                                                                                                                                                                                                            |

|            |                                    |
|------------|------------------------------------|
| <b>42.</b> | Optical flow methods               |
| <b>43.</b> | Block based methods                |
| <b>44.</b> | Bayesian method                    |
| <b>45.</b> | Video Coding standards             |
| <b>46.</b> | Video compression standards: H2.61 |
| <b>47.</b> | Video structure and bit-stream     |
| <b>48.</b> | Scalable coding                    |
| <b>49.</b> | Data partitioning                  |
| <b>50.</b> | Comparison of MPEG-1 and MPEG-2    |

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| Name of Program                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | BTech                    | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Advanced Instrumentation |                           |                                       |
| Course Code                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ECE 463                  |                           |                                       |
| Core / Elective / Other              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Elective                 |                           |                                       |
| Prerequisite:                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 1.                                   | Electronic Instrumentation and Measurement, Electronic Circuits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| Course Outcomes:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 1.                                   | Introduce students to the major ideas, methods, and techniques of Advanced Instrumentation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |                           |                                       |
| 2.                                   | To demonstrate the fundamentals and techniques of Measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 3.                                   | To make students familiar with various issues in the design of Instrumentation System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                          |                           |                                       |
| 4.                                   | Students will be able to understand various instrument interfaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                          |                           |                                       |
| 5.                                   | Students will be able to develop domain specific virtual instrumentation system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |                           |                                       |
| Description of Contents in brief:    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 1.                                   | <p>Conductivity measurement. Smart sensors-block diagram, Smart transmitter. Recent trends in sensor technology – Semiconductor sensors–Film sensors-MEMS-Nanosensors.</p> <p>Voltage, Time, Phase measurement using digital techniques –Input circuits of digital voltmeter–auto zero circuit–bipolar operation–buffer circuit–protection–auto ranging–tracking method. Ratiometric Measurements–Applications–Measurement of modulation index, Q of a coil Noise in instrumentation systems, electromagnetic interference, methods of noise coupling, noise sources, grounding.</p> <p>Virtual Instrumentation–concepts–historical perspective–virtual versus real instrumentation–advantages of virtual instrumentation–block diagram and architecture of a virtual instrument–Physical quantities and analog interfaces– Hardware and software–User Interfaces–Applications of virtual instrumentation.</p> <p>Common Instrument Interfaces – RS232C, RS422A, RS 432A, RS485A, USB, General Purpose Interface Bus (GPIB), Standard Commands for Programmable Instrumentation (SCPI), VME Extensions for Instrumentation (VXI), Multisystem Extension Interface (MXIbus), Enhanced Parallel Port. Virtual Instrument Software Architecture</p> |                          |                           |                                       |
| List of Text Books:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 1.                                   | D. Patranabis, Principles of Industrial Instrumentation, 2nd ed., Tata McGraw Hill, New Delhi, 1996                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |                           |                                       |
| 2.                                   | T. S. Rathore, Digital Measurement Techniques, 2nd ed., Narosa Publishing House, New Delhi, 2004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                          |                           |                                       |
| List of Reference Books:             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 1.                                   | G. W. Johnson, LabVIEW Graphical Programming: Practical Application in Instrumentation and Control, 2nd ed., McGraw Hill, New York, 1997.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                          |                           |                                       |
| 2.                                   | H. R. Taylor, Data Acquisition for Sensor Systems, Chapman & Hall, London, 1992                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| 3.                                   | J. Y. Beyon, Hands-On Exercise Manual for LabVIEW Programming, Data Acquisition and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |                           |                                       |
| URLs:                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                           |                                       |

| Lecture No. | Topic                                                                |
|-------------|----------------------------------------------------------------------|
| 1.          | Conductivity measurement                                             |
| 2.          | Smart sensors-block diagram                                          |
| 3.          | Smart transmitter                                                    |
| 4.          | Recent trends in sensor technology                                   |
| 5.          | Semiconductor sensors                                                |
| 6.          | Film-sensors                                                         |
| 7.          | MEMS                                                                 |
| 8.          | Nanosensors                                                          |
| 9.          | Input circuits of digital voltmeter                                  |
| 10.         | Auto zero circuit                                                    |
| 11.         | Bipolar operation                                                    |
| 12.         | Buffer circuit                                                       |
| 13.         | Protections                                                          |
| 14.         | Auto ranging                                                         |
| 15.         | Tracking method                                                      |
| 16.         | Voltage measurement using digital techniques                         |
| 17.         | Time measurement using digital techniques                            |
| 18.         | Phase measurement using digital techniques                           |
| 19.         | Ratiometric Measurements                                             |
| 20.         | Applications of Ratiometric Measurements                             |
| 21.         | Measurement of modulation index                                      |
| 22.         | Measurement of modulation index                                      |
| 23.         | Q of a coil                                                          |
| 24.         | Noise in instrumentation systems                                     |
| 25.         | Electromagnetic interference                                         |
| 26.         | Methods of noise coupling                                            |
| 27.         | Noise sources                                                        |
| 28.         | Grounding                                                            |
| 29.         | Virtual Instrumentation concepts                                     |
| 30.         | Historical perspective                                               |
| 31.         | Virtual versus real instrumentation                                  |
| 32.         | Advantages of virtual instrumentation                                |
| 33.         | Block diagram of virtual instrument                                  |
| 34.         | Architecture of virtual instrument                                   |
| 35.         | Physical quantities                                                  |
| 36.         | analog interfaces                                                    |
| 37.         | Hardware and software–User Interfaces                                |
| 38.         | Applications of virtual instrumentation                              |
| 39.         | Common Instrument Interfaces – RS232C, RS422A, RS 432A, RS485A, USB, |
| 40.         | General Purpose Interface Bus (GPIB)                                 |
| 41.         | Standard Commands for Programmable Instrumentation (SCPI)            |
| 42.         | VME Extensions for Instrumentation (VXI)                             |
| 43.         | Multisystem Extension Interface (MXIbus)                             |
| 44.         | Enhanced Parallel Port                                               |
| 45.         | Virtual Instrument Software Architecture                             |

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|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------|
| Name of Program                   | B.Tech.                                                                                                                                                                                                                 | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    | Multirate Signal Processing                                                                                                                                                                                             |                           |                                       |
| Course Code                       | ECE 464                                                                                                                                                                                                                 |                           |                                       |
| Core / Elective / Other           | Elective                                                                                                                                                                                                                |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                         |                           |                                       |
| 1.                                | Fundamental knowledge of Communication systems                                                                                                                                                                          |                           |                                       |
| 2.                                | Basic knowledge of Signals and Systems                                                                                                                                                                                  |                           |                                       |
| 3.                                | Fundamental knowledge of Digital Signal Processing                                                                                                                                                                      |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                         |                           |                                       |
| 1.                                | Introduces multirate digital signal processing along with different forms of filter bank applications.                                                                                                                  |                           |                                       |
| 2.                                | Homomorphic signals and systems are discussed with cepstral analysis.                                                                                                                                                   |                           |                                       |
| 3.                                | Different types of adaptive filters with its application are elaborated.                                                                                                                                                |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                         |                           |                                       |
| 1.                                | Adaptive filtering: Principle of Adaptive filters, Tapped delay Line and Weiner filters, Steepest Descent Algorithm, Least Mean Square (LMS) Algorithm, Direct Least Square and Recursive Least Square (RLS) Algorithms |                           |                                       |
| 2.                                | Application of Adaptive filters: Noise canceller, Echo canceller, Side Lobe Canceller, Adaptive Line Enhancer.                                                                                                          |                           |                                       |
| 3.                                | Multi-rate Signal Processing: Multi-rate Systems, Decimation and Interpolation (integer and fractional), Decimation Filters, Interpolation Filter                                                                       |                           |                                       |
| 4.                                | M-channel perfect reconstruction filter banks                                                                                                                                                                           |                           |                                       |
| 5.                                | Cosine Modulated filterbanks. Polyphase structure- PR Systems.                                                                                                                                                          |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                         |                           |                                       |
| 1.                                | P.P. Vaidyanathan. "Multirate systems and filter banks." Prentice Hall. PTR.                                                                                                                                            |                           |                                       |
| 2.                                | N.J. Fliege. "Multirate digital signal processing ." John Wiley                                                                                                                                                         |                           |                                       |
| 3.                                | Sanjit K. Mitra. " Digital Signal Processing: A computer based approach." McGraw                                                                                                                                        |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                                                                         |                           |                                       |
| 1.                                | R.E. Crochiere. L. R. "Multirate Digital Signal Processing", Prentice Hall. Inc.                                                                                                                                        |                           |                                       |
| 2.                                | J.G. Proakis. D.G. Manolakis. "Digital Signal Processing: Principles. Algorithms and Applications", 3rd Edn. Prentice Hall India                                                                                        |                           |                                       |
| 3.                                |                                                                                                                                                                                                                         |                           |                                       |
| URLs:                             |                                                                                                                                                                                                                         |                           |                                       |
| 1.                                | <a href="https://swayam.gov.in/nd1_noc20_ee21/preview">https://swayam.gov.in/nd1_noc20_ee21/preview</a>                                                                                                                 |                           |                                       |
| 2.                                | <a href="https://nptelmooc2013.appspot.com/noc19_ee27/preview">https://nptelmooc2013.appspot.com/noc19_ee27/preview</a>                                                                                                 |                           |                                       |

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|---------------------------------------------|---------------------------------------------------------------------------------------|
| 3.                                          |                                                                                       |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                       |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                          |
| 1                                           | Signals, Fourier representations, DFT & FFT, IIR and FIR filters                      |
| 2                                           | Homomorphic system, complex Cepstrum,                                                 |
| 3                                           | properties of complex cepstrum, complex cepstrum of exponential signals,              |
| 4                                           | Real Cepstrum, Implementation of cepstrum using DFT,                                  |
| 5                                           | Tutorial                                                                              |
| 6                                           | Hilbert transform relations in cepstral analysis,                                     |
| 7                                           | Hilbert transform relations in cepstral analysis,                                     |
| 8                                           | convolution and deconvolution, Examples of Homomorphic signal                         |
| 9                                           | Fundamentals of Multirate Theory: The sampling theorem - sampling at sub-Nyquist rate |
| 10                                          | Fundamentals of Multirate Theory: The sampling theorem - sampling at sub-Nyquist rate |
| 11                                          | Basic Formulations and schemes - Basic Multirate operations                           |
| 12                                          | Basic Formulations and schemes - Basic Multirate operations                           |
| 13                                          | Tutorial                                                                              |
| 14                                          | Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank-Identities       |
| 15                                          | Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank-Identities       |
| 16                                          | Polyphase representation - Maximally decimated filter banks: Polyphase representation |
| 17                                          | Polyphase representation - Maximally decimated filter banks: Polyphase representation |
| 18                                          | Errors in the QMF bank- Perfect Reconstruction (PR) QMF Bank                          |
| 19                                          | Errors in the QMF bank- Perfect Reconstruction (PR) QMF Bank                          |
| 20                                          | Design of an alias free QMF Bank                                                      |
| 21                                          | Design of an alias free QMF Bank                                                      |
| 22                                          | Tutorial                                                                              |
| 23                                          | M-channel perfect reconstruction filter banks: tree structured filter bank            |
| 24                                          | M-channel perfect reconstruction filter banks: tree structured filter bank            |
| 25                                          | Uniform band and non uniform filter bank                                              |
| 26                                          | Uniform band and non uniform filter bank                                              |
| 27                                          | Errors created by filter bank system                                                  |
| 28                                          | Errors created by filter bank system                                                  |
| 29                                          | Tutorial                                                                              |
| 30                                          | Polyphase representation- perfect reconstruction systems                              |
| 31                                          | Polyphase representation- perfect reconstruction systems                              |
| 32                                          | Perfect reconstruction (PR) filter banks: Two channel FIR paraunitary QMF Bank        |
| 33                                          | Para-unitary PR Filter Banks                                                          |
| 34                                          | Para-unitary PR Filter Banks                                                          |
| 35                                          | Tutorial                                                                              |
| 36                                          | Filter Bank Properties induced by paraunitarity                                       |
| 37                                          | Filter Bank Properties induced by paraunitarity fix to prefix conversion              |

|    |                                                                              |
|----|------------------------------------------------------------------------------|
| 38 | Linear phase PR Filter banks- Necessary conditions for Linear phase property |
| 39 | Linear phase PR Filter banks- Necessary conditions for Linear phase property |
| 40 | Linear phase PR Filter banks- Necessary conditions for Linear phase property |
| 41 | Tutorial                                                                     |
| 42 | Principle of Adaptive filters,                                               |
| 43 | Tapped delay Line and Weiner filters                                         |
| 44 | Steepest Descent Algorithm, Least Mean Square (LMS) Algorithm                |
| 45 | Direct Least Square and Recursive Least Square (RLS) Algorithms              |

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                           |                                       |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | B. Tech                          | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Micro Electro Mechanical Systems |                           |                                       |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ECE 465                          |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Elective                         |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                           |                                       |
| 1.                                | The students are well versed with the fundamentals of Material Science.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                           |                                       |
| 1.                                | Students will explain MEMS Technology, Present, Future and Challenges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |                           |                                       |
| 2.                                | Students will be able to explain micro sensors, micro-actuators, their types and applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                  |                           |                                       |
| 3.                                | Students will be able to explain about fabrication processes for producing micro-sensors and actuators. They will also be able to apply Reliability, and Failure Analysis Testing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                  |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                           |                                       |
| 1.                                | Introduction, Development of MEMS Technology, Present, Future and Challenges, Fabrication Processes: Fundamentals of Material Science, Substrates: Single crystal substrates, Silicon on Insulator Substrate, Physical vapour deposition, Chemical vapour Deposition, Etching Processes, patterning, wafer bonding, annealing, chemical mechanical polishing, material doping, MEMS application in life sciences.                                                                                                                                                                                                                                                                                 |                                  |                           |                                       |
| 2.                                | Principal of Microsystems: Introduction, Microsensors and there types, Microactuation using different forces and materials, Microactuators and there types, Microaccelerometers, Microfluidics Scaling Laws in Miniaturization: Introduction to scaling, Scaling of physical systems scaling (geometric, mechanical, thermal, fluidic, electrical, optical and chemical and biological), computational fabrication, and material issues Materials and Microsystems: Introduction, Substrates and wafers, active substrate materials, Silicon as a substrate material, Silicon compounds, silicon piezoresistors, Gallium Arsenide, Quarta, Piezoelectric crystals, polymers, packaging materials. |                                  |                           |                                       |
| 3.                                | Microsystem Fabrication Process and Manufacturing: Introduction, Photolithography, Ion implantation, Diffusion, Oxidation, Chemical vapour deposition, physical vapour deposition, Chemical Mechanical Polishing, Material Doping, Deposition of epitaxy, Etching, Patterning, wafer-bonding and annealing. Micromanufacturing: Bulk micromachining, Surface micromachining, LIGA, Packaging and Reliability: Packaging process steps, reliability models, MEMS failure mechanisms, Measurement Techniques for MEMS Operational, Reliability, and Failure Analysis Testing.                                                                                                                       |                                  |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                           |                                       |
| 1.                                | Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, Fourth reprint edition, 2012.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |                           |                                       |
| 2.                                | Allen James J, Micro Electromechanical System Design, First edition, Taylor and Farancis, FL (USA), 2005.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                  |                           |                                       |

| 3.                                          | MalufNadim and Williams Kirt, An Introduction to Microelectromechanical Systems Engineering, Second Edition, ARTECH House, MA (USA), 2004. |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>List of Reference Books:</b>             |                                                                                                                                            |
| 1.                                          | N. Maluf," An Introduction to Micro-electro Mechanical System Engineering", Artech. House.                                                 |
| 2.                                          | S. Senturia," Micro system Design", Springer.                                                                                              |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                            |
| Lecture No.                                 | Topic                                                                                                                                      |
| 1.                                          | Introduction, Development of MEMS Technology, Present, Future and Challenges.                                                              |
| 2.                                          | Fabrication Processes: Fundamentals of Material Science.                                                                                   |
| 3.                                          | Substrates: Single crystal substrates.                                                                                                     |
| 4.                                          | Silicon on Insulator Substrate.                                                                                                            |
| 5.                                          | Physical vapour deposition.                                                                                                                |
| 6.                                          | Chemical vapour Deposition.                                                                                                                |
| 7.                                          | Etching Processes.                                                                                                                         |
| 8.                                          | Patterning.                                                                                                                                |
| 9.                                          | Wafer bonding.                                                                                                                             |
| 10.                                         | Annealing.                                                                                                                                 |
| 11.                                         | Chemical mechanical polishing.                                                                                                             |
| 12.                                         | Material doping.                                                                                                                           |
| 13.                                         | MEMS application in life sciences.                                                                                                         |
| 14.                                         | Principal of Microsystems: Introduction, Microsensors and there types.                                                                     |
| 15.                                         | Microactuation using different forces and materials.                                                                                       |
| 16.                                         | Microactuators and there types                                                                                                             |
| 17.                                         | Microaccelerometers.                                                                                                                       |
| 18.                                         | Microfluidics Scaling Laws in Miniaturization: Introduction to scaling.                                                                    |
| 19.                                         | Scaling of physical systems scaling (geometric, mechanical, thermal, fluidic, electrical, optical and chemical and biological).            |
| 20.                                         | Computational fabrication.                                                                                                                 |
| 21.                                         | Material issues Materials and Microsystems: Introduction.                                                                                  |
| 22.                                         | Substrates and wafers.                                                                                                                     |
| 23.                                         | Active substrate materials.                                                                                                                |
| 24.                                         | Silicon as a substrate material, Silicon compounds.                                                                                        |
| 25.                                         | Silicon piezoresistors.                                                                                                                    |
| 26.                                         | Gallium Arsenide, Quartz, Piezoelectric crystals.                                                                                          |
| 27.                                         | Polymers, packaging materials.                                                                                                             |
| 28.                                         | Microsystem Fabrication Process and Manufacturing: Introduction.                                                                           |
| 29.                                         | Photolithography.                                                                                                                          |
| 30.                                         | Ion implantation.                                                                                                                          |
| 31.                                         | Diffusion.                                                                                                                                 |
| 32.                                         | Oxidation                                                                                                                                  |
| 33.                                         | Chemical vapour deposition, physical vapour deposition,                                                                                    |
| 34.                                         | Chemical Mechanical Polishing.                                                                                                             |
| 35.                                         | Material Doping.                                                                                                                           |
| 36.                                         | Deposition of epitaxy.                                                                                                                     |

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|-----|-----------------------------------------------------|
| 37. | Etching.                                            |
| 38. | Patterning.                                         |
| 39. | Wafer-bonding and annealing.                        |
| 40. | Micromanufacturing: Bulk micromachining.            |
| 41. | Surface micromachining.                             |
| 42. | LIGA.                                               |
| 43. | Packaging and Reliability: Packaging process steps. |
| 44. | Reliability models.                                 |
| 45. | MEMS failure mechanisms.                            |
| 46. | Measurement Techniques for MEMS Operational.        |
| 47. | Reliability and Failure Analysis Testing.           |

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| Name of Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | B Tech                        | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Statistical Signal Processing |                           |                                       |
| Course Code                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ECE 466                       |                           |                                       |
| Core / Elective / Other           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Elective                      |                           |                                       |
| Prerequisite:                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 1.                                | Probability ,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |                           |                                       |
| 2.                                | Basic signal, system, signal analysis technique                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 3.                                | Statistical analysis techniques                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| Course Outcomes:                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 1.                                | Understanding of autoregressive, moving average, autoregressive moving average, and general linear models and how they are related.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |                           |                                       |
| 2.                                | Ability to apply nonparametric techniques to estimate autocorrelation, cross-correlation, and partial correlation, Ability to characterize an estimator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               |                           |                                       |
| 3.                                | Ability to conduct and present a peer-reviewed research project orally and in written form                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                               |                           |                                       |
| Description of Contents in brief: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 1.                                | Random variables and Moments, Moment generating function, Random Vector, Nonstationary signal analysis, Random Processes: Definition and Classification, Stochastic integrals, Stationary and Non-stationary processes, Ergodicity, Correlation functions. Special random processes (white Gaussian noise, Wiener-Levy processes, shot-noise processes, Optimum Filtering: Matched filters, Wiener filters for random signals in white and colored Gaussian noise, Discrete and continuous time filters, Kalman filter and its application, Power spectrum estimation, Wiener, Adaptive Filtering, Wavelet Analysis. Power Spectrum Estimation, Least square Lattice filters, Signal Analysis with Higher order Spectra, Array processing, Beam-forming, Time-delay estimation. Parametric and Non parametric estimation, Power Spectrum Estimation-Parametric and Maximum Entropy Methods, Levinson-Durban Algorithms Least Square Method, MLE, Cholesky decomposition, LDU-OR, SV decomposition. |                               |                           |                                       |
| List of Text Books:               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 1.                                | Statistical Digital Signal Processing and Modelling M. Hays, John Willey and Sons, 1996.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               |                           |                                       |
| 2.                                | Statistical Signal Processing with Applications M.D. Srinath, P.K. Rajasekaran and R. Viswanathan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               |                           |                                       |
| 3.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| List of Reference Books:          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 1.                                | Detection, Estimation and Modulation, H.L. Van Trees,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               |                           |                                       |
| 2.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 3.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| URLs: Nil                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |
| 1.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                           |                                       |

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3.                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                             | <ol style="list-style-type: none"> <li>1. Discrete-Time Processing:</li> <li>2. Discrete-Time Systems:</li> <li>3. Random Variables:</li> <li>4. Stochastic Signals:</li> <li>5. Estimation Theory:</li> <li>6. Signal Models [2lect]:</li> <li>7. Autocorrelation:</li> <li>8. Windowing:</li> <li>9. Spectral Estimation:</li> <li>10. Joint Signal Analysis:</li> <li>11. Coherence Analysis:</li> <li>12. Time-Frequency Analysis:</li> <li>13. Linear Estimation:</li> <li>14. Optimum FIR Filters:</li> <li>15. Linear Prediction:</li> <li>16. Optimum IIR Filters:</li> <li>17. Optimum Linear Filter Applications[2 lect]:</li> <li>18. Order-Recursive Algorithms[2 lect]:</li> <li>19. Innovations:</li> <li>20. State Space Models[2 lect]:</li> <li>21. Kalman Filter:</li> <li>22. Extended Kalman Filter:</li> <li>23. Least-Squares Estimation[2 lect]:</li> <li>24. Practical Modeling[2 lect]:</li> <li>25. Autoregressive Models[2 lect]:</li> <li>26. Pole-Zero Models</li> <li>27. Minimum-Variance Spectrum Estimation[2lect]</li> <li>28. Frequency Estimation [2lect]</li> </ol> |

|                                      |                                                                                                                     |                              |                           |                                       |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------|---------------------------------------|
| Name of Program                      |                                                                                                                     | BTech                        | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                     | Biomedical Signal Processing |                           |                                       |
| Course Code                          |                                                                                                                     | ECE 467                      |                           |                                       |
| Core / Elective / Other              |                                                                                                                     | Elective                     |                           |                                       |
| Prerequisite:                        |                                                                                                                     |                              |                           |                                       |
| 1.                                   | Digital Image Processing, Digital Signal Processing                                                                 |                              |                           |                                       |
| Course Outcomes:                     |                                                                                                                     |                              |                           |                                       |
| 1.                                   | Introduce students to the major medical signal modelities and their acquisition system.                             |                              |                           |                                       |
| 2.                                   | To demonstrate the various signal processing techniques of medical signals.                                         |                              |                           |                                       |
| 3.                                   | To make students familiar with various medical signal analysis metho .                                              |                              |                           |                                       |
| 4.                                   | Students will be able to develop signal processing algorithms for enhancement, denoising, compression.              |                              |                           |                                       |
| 5.                                   | Students will be able to develop domain specific medical signal classification models for computer aided diagnosis. |                              |                           |                                       |
| Description of Contents in brief:    |                                                                                                                     |                              |                           |                                       |
| 1.                                   | Biomedical Signals                                                                                                  |                              |                           |                                       |
| 2.                                   | Biomedical Signal Acquisition Systems                                                                               |                              |                           |                                       |
| 3.                                   | Medical Signal formats                                                                                              |                              |                           |                                       |
| 4.                                   | Medical Signal Processing                                                                                           |                              |                           |                                       |
| 5.                                   | Medical SignalAnalysis                                                                                              |                              |                           |                                       |
| 6.                                   | Computer aided diagnosis                                                                                            |                              |                           |                                       |
| List of Text Books:                  |                                                                                                                     |                              |                           |                                       |
| 1.                                   | Biomedical Signal and Image Processing, KayvanNajarian, Robert Splinter, CRC Press, 2016                            |                              |                           |                                       |
| 2.                                   | Medical Imaging Signals and Systems, Jerry L. Prince, Jonathan Links, 4 <sup>th</sup> Edition, Pearson, 2015.       |                              |                           |                                       |
| List of Reference Books:             |                                                                                                                     |                              |                           |                                       |
| 1.                                   | Biomedical Image Processing, Thomas M. Deserno, Springer Science & Business Media, 2011                             |                              |                           |                                       |
| 2.                                   | Biomedical Signal Analysis, Rangaraj M. Rangayyan, John Wiley and Sons, 2015                                        |                              |                           |                                       |
| 3.                                   | Medical image processing, G.R. Sinha, BhagwatiCharan Patel, 1 <sup>st</sup> Edition, PHI, 2014.                     |                              |                           |                                       |
| 4.                                   | Machine Learning, SaikatDutt, Subramanian Chandramouli, Amit Kumar Das, 1 <sup>st</sup> Edition, Pearson, 2018.     |                              |                           |                                       |
| 5.                                   | Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Pearson, 2015.         |                              |                           |                                       |
| URLs:                                |                                                                                                                     |                              |                           |                                       |
| 1.                                   |                                                                                                                     |                              |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                     |                              |                           |                                       |
| Lecture No.                          | Topic                                                                                                               |                              |                           |                                       |
| 1.                                   | Review of Digital Image Processing                                                                                  |                              |                           |                                       |
| 2.                                   | Review of Digital Signal Processing                                                                                 |                              |                           |                                       |
| 3.                                   | Introduction to biomedical Signals                                                                                  |                              |                           |                                       |

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|-----|----------------------------------------------------------------------------|
| 4.  | Radiographic Images                                                        |
| 5.  | Radiographic Image Acquisition System                                      |
| 6.  | Enhancement, Restoration, Segmentation and compression of medical Signals. |
| 7.  | Tomographic Images                                                         |
| 8.  | Tomographic Image Acquisition System                                       |
| 9.  | Tomographic Image reconstruction                                           |
| 10. | Magnetic Resonance Images                                                  |
| 11. | Magnetic Resonance Acquisition System                                      |
| 12. | Magnetic Resonance Reconstruction                                          |
| 13. | Ultrasound Images                                                          |
| 14. | Ultrasound Image Acquisition System                                        |
| 15. | Medical Image formats I                                                    |
| 16. | Medical Image formats II                                                   |
| 17. | Enhancement of Medical signals                                             |
| 18. | Compression of Medical signals                                             |
| 19. | Denoising of Medical signals                                               |
| 20. | Statistical measurement based signal processing systems I                  |
| 21. | Statistical measurement based signal processing systems II                 |
| 22. | Feature extraction                                                         |
| 23. | Medical signal processing in spatial domain I                              |
| 24. | Medical signal processing in spatial domain II                             |
| 25. | Medical signal processing in spatial domain III                            |
| 26. | Medical signal processing in frequency domain I                            |
| 27. | Medical signal processing in frequency domain II                           |
| 28. | Medical signal processing in frequency domain III                          |
| 29. | Texture based analysis I                                                   |
| 30. | Texture based analysis II                                                  |
| 31. | Shape based analysis I                                                     |
| 32. | Shape based analysis II                                                    |
| 33. | Object detection and extraction I                                          |
| 34. | Object detection and extraction II                                         |
| 35. | Computer aided diagnostic techniques I                                     |
| 36. | Computer aided diagnostic techniques II                                    |
| 37. | Computer aided diagnostic techniques III                                   |
| 38. | Classification of medical signals I                                        |
| 39. | Classification of medical signals II                                       |
| 40. | Classification of medical signals III                                      |

|                                   |                                                                                                                            |             |                           |                                       |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                            | B.Tech      | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                            | Fuzzy Logic |                           |                                       |
| Course Code                       |                                                                                                                            | ECE 468     |                           |                                       |
| Core / Elective / Other           |                                                                                                                            | Elective    |                           |                                       |
| Prerequisite:                     |                                                                                                                            |             |                           |                                       |
| 1.                                | Elementary Set Theory(M3)                                                                                                  |             |                           |                                       |
| 2.                                | Elementary Probability Theory(M3)                                                                                          |             |                           |                                       |
| 3.                                |                                                                                                                            |             |                           |                                       |
| Course Outcomes:                  |                                                                                                                            |             |                           |                                       |
| 1.                                | Learning concepts of Fuzzy Set Theory and Fuzzy Logic.                                                                     |             |                           |                                       |
| 2.                                | Gaining knowledge about Fuzzy rule base systems and performance analysis                                                   |             |                           |                                       |
| 3.                                | Formulating and solving various real life problems using concepts of Fuzzy logic.                                          |             |                           |                                       |
| Description of Contents in brief: |                                                                                                                            |             |                           |                                       |
| 1.                                | Classical Set and Fuzzy set Theory                                                                                         |             |                           |                                       |
| 2.                                | Classical and Fuzzy Relations                                                                                              |             |                           |                                       |
| 3.                                | Fuzzification and Defuzzifications                                                                                         |             |                           |                                       |
| 4.                                | Development of Membership function                                                                                         |             |                           |                                       |
| 5.                                | Fuzzy Logic and Fuzzy Systems                                                                                              |             |                           |                                       |
| 6.                                | Decision Making with Fuzzy Information                                                                                     |             |                           |                                       |
| 7.                                | Fuzzy Classification                                                                                                       |             |                           |                                       |
| 8.                                | Fuzzy Pattern Recognition                                                                                                  |             |                           |                                       |
| 9.                                | Fuzzy Control Systems                                                                                                      |             |                           |                                       |
| 10.                               | Miscellaneous Topics                                                                                                       |             |                           |                                       |
| List of Text Books:               |                                                                                                                            |             |                           |                                       |
| 1.                                | Timothy J. Ross, Fuzzy Logic With Engineering Applications, 3 <sup>rd</sup> ed. Wiley, 2010                                |             |                           |                                       |
| 2.                                | George J Klir / Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson, 2015                                |             |                           |                                       |
| 3.                                | A.K. Bhargava, Fuzzy Set Theory Fuzzy Logic and their Applications, S.Chand and Comp, 2013                                 |             |                           |                                       |
| List of Reference Books:          |                                                                                                                            |             |                           |                                       |
| 1.                                | LotfiA.Zadeh and Rafik A. Aliev, Fuzzy Logic theory and Applications, World Scientific, 2018.                              |             |                           |                                       |
| 2.                                | M.K. Hasan, Fuzzy Sets and Fuzzy Logic with Applications: Imprecision, Uncertainty and Vagueness, Scholar's Press, 2019    |             |                           |                                       |
| 3.                                | Hans-Jurgen Zimmermann, Practical Applications of Fuzzy Technologies (The Handbooks of Fuzzy Sets), 2012, Springer Science |             |                           |                                       |

**URLs:**

- |    |                                                                                                         |
|----|---------------------------------------------------------------------------------------------------------|
| 1. | <a href="https://www.tutorialspoint.com › fuzzy_logic">https://www.tutorialspoint.com › fuzzy_logic</a> |
| 2. | <a href="https://www.guru99.com/">https://www.guru99.com/</a>                                           |
| 3. | <a href="https://www.youtube.com/watch?v=a2i-lHS-c_I">https://www.youtube.com/watch?v=a2i-lHS-c_I</a>   |

**Lecture Plan (about 40-50 Lectures):**

| Lecture No. | Topic                                                       |
|-------------|-------------------------------------------------------------|
| 1.          | Introduction and historical aspects of Fuzzy set theory     |
| 2.          | Classical set theory and Fuzzy set theory                   |
| 3.          | Fuzzy membership functions                                  |
| 4.          | Fuzzy union, intersection and complement operations         |
| 5.          | Graphical representations of Fuzzy operations               |
| 6.          | Cartesian product and Fuzzy Relations                       |
| 7.          | Fuzzy Compositions                                          |
| 8.          | Fuzzy equivalence Relations                                 |
| 9.          | Value assignments for Fuzzy Relations                       |
| 10.         | Fuzzy Set elements and Properties                           |
| 11.         | Concepts of Fuzzification and Defuzzifications              |
| 13.         | Methods of Defuzzification                                  |
| 14.         | Alpha Cut for Crisp conversion                              |
| 15.         | Alpha Cut for Fuzzy Equivalence Relation                    |
| 16.         | Fuzzy Propositions                                          |
| 17.         | Fuzzy Implications                                          |
| 18.         | Concepts of Fuzzy Rule based Systems                        |
| 19.         | Mamdani Fuzzy Rule based Systems                            |
| 20.         | Sugeno (TSK) Fuzzy Rule based Systems                       |
| 21.         | Tsukamoto Fuzzy Rule based Systems                          |
| 22.         | Development of Fuzzy membership functions                   |
| 23.         | Intuition and Inference method                              |
| 24.         | Rank ordering and Neural network method                     |
| 25.         | Other methods for development of Fuzzy membership functions |
| 26.         | Fuzzy Decision Masking                                      |
| 27.         | Fuzzy Ordering                                              |
| 28.         | Nontransitive Ranking                                       |
| 29.         | Preference and Consensus                                    |
| 30.         | Multiobjective Decision Making: Concepts and Requirements   |
| 31.         | Multiobjective Decision Making: Examples                    |
| 32.         | Multiobjective Decision Making: Practical Applications      |
| 33.         | Fuzzy Bayesian Decision Making: Concepts and requirements   |
| 34.         | Fuzzy Bayesian Decision Making: Examples                    |
| 35.         | Decision Making Under Fuzzy States                          |
| 36.         | Fuzzy Classification                                        |
| 37.         | Fuzzy Clustering                                            |
| 38.         | Fuzzy C-Means Clustering                                    |
| 39.         | Fuzzy C-Means Clustering (Cont.)                            |
| 40.         | Hard C-Means and Fuzzy C-Means Algorithms                   |

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| 41. | Fuzzy pattern Recognition              |
| 42. | Feature Analysis                       |
| 43. | Single Sample Identification           |
| 44. | Multi Feature Pattern Recognition      |
| 45. | Fuzzy Extension Principles             |
| 46. | Approximate Methods of Fuzzy Extension |
| 47. | Fuzzy control Systems                  |
| 48. | Simple Fuzzy Logic Controllers         |
| 49. | Fuzzy Logic Controllers (Cont.)        |
| 50. | Industrial Applications                |

|                                   |                                                                                                                                         |                 |                           |                                       |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------|---------------------------------------|
| Name of Program                   |                                                                                                                                         | B.Tech          | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                    |                                                                                                                                         | Neural Networks |                           |                                       |
| Course Code                       |                                                                                                                                         | ECE 469         |                           |                                       |
| Core / Elective / Other           |                                                                                                                                         | Elective        |                           |                                       |
| Prerequisite:                     |                                                                                                                                         |                 |                           |                                       |
| 1.                                | -                                                                                                                                       |                 |                           |                                       |
| 2.                                | -                                                                                                                                       |                 |                           |                                       |
| 3.                                | --                                                                                                                                      |                 |                           |                                       |
| Course Outcomes:                  |                                                                                                                                         |                 |                           |                                       |
| 1.                                | Learning concepts of Neural Networks.                                                                                                   |                 |                           |                                       |
| 2.                                | Gaining knowledge about Neural Networks based systems                                                                                   |                 |                           |                                       |
| 3.                                | Formulating and solving various real life problems using concepts of ANN.                                                               |                 |                           |                                       |
| Description of Contents in brief: |                                                                                                                                         |                 |                           |                                       |
| 1.                                | Introduction to ANN                                                                                                                     |                 |                           |                                       |
| 2.                                | Artificial Neurons architectures                                                                                                        |                 |                           |                                       |
| 3.                                | Learning Algorithms                                                                                                                     |                 |                           |                                       |
| 4.                                | Neural Network Architectures                                                                                                            |                 |                           |                                       |
| 5.                                | Feed forward and Fee Back Neural Networks                                                                                               |                 |                           |                                       |
| 6.                                | Self Organizing Feature Maps (SOM)                                                                                                      |                 |                           |                                       |
| 7.                                | Concepts of Machine Learning                                                                                                            |                 |                           |                                       |
| 8.                                | Convolutional Neural Networks                                                                                                           |                 |                           |                                       |
| 9.                                | Applications of CNN                                                                                                                     |                 |                           |                                       |
| 10.                               | Miscellaneous Topics                                                                                                                    |                 |                           |                                       |
| List of Text Books:               |                                                                                                                                         |                 |                           |                                       |
| 1.                                | Simon Haykin, “Neural Networks: A Comprehensive Foundations”, MacMillan Publishing Company, 1994                                        |                 |                           |                                       |
| 2.                                | Satish Kumar, “Neural Networks: A Classroom Approach”, McGraw Hill Education, 2004                                                      |                 |                           |                                       |
| 3.                                | Mohamad Hassoun, “Fundamentals of Artificial Neural Networks”, MIT Press, 2003                                                          |                 |                           |                                       |
| List of Reference Books:          |                                                                                                                                         |                 |                           |                                       |
| 1.                                | Tariq Rashid, “Make Your Own Neural Network: A Gentle Journey Through the Mathematics of Neural Networks” Kindle, 2016.                 |                 |                           |                                       |
| 2.                                | Wolfgang Beer, “Applied Artificial Intelligence: Neural networks and deep learning with Python and Tensor Flow”, Kindle, 2017.          |                 |                           |                                       |
| 3.                                | <a href="#">P.J. Braspenning</a> , “Artificial Neural Networks: An Introduction to ANN Theory and Practice”, Springer 1995.             |                 |                           |                                       |
| URLs:                             |                                                                                                                                         |                 |                           |                                       |
| 1.                                | <a href="https://www.coursera.org/learn/neural-networks-deep-learning">https://www.coursera.org/learn/neural-networks-deep-learning</a> |                 |                           |                                       |
| 2.                                | <a href="https://www.coursera.org/learn/machine-learning">https://www.coursera.org/learn/machine-learning</a>                           |                 |                           |                                       |

|                                             |                                                                                                 |
|---------------------------------------------|-------------------------------------------------------------------------------------------------|
| 3.                                          | <a href="https://www.edx.org/learn/neural-network">https://www.edx.org/learn/neural-network</a> |
| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                                 |
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                    |
| 1.                                          | Introduction and historical aspects of Neural Networks                                          |
| 2.                                          | Components of biological Neurons                                                                |
| 3.                                          | Artificial Neuron Models                                                                        |
| 4.                                          | Aggregation Functions                                                                           |
| 5.                                          | Activation Functions                                                                            |
| 6.                                          | Errors and error functions                                                                      |
| 7.                                          | Concept and importance of learning rate                                                         |
| 8.                                          | Concepts of Learning methods                                                                    |
| 9.                                          | Supervised Learning Methods                                                                     |
| 10.                                         | Supervised Learning Methods (Cont.)                                                             |
| 11.                                         | Supervised Learning Methods (Cont.)                                                             |
| 13.                                         | Unsupervised Learning Methods                                                                   |
| 14.                                         | Unsupervised Learning Methods (Cont.)                                                           |
| 15.                                         | Unsupervised Learning Methods (Cont.)                                                           |
| 16.                                         | Reinforcement Learning                                                                          |
| 17.                                         | Neural network Architectures                                                                    |
| 18.                                         | Feed Forward Neural Networks                                                                    |
| 19.                                         | Feed Forward Neural Networks (cont.)                                                            |
| 20.                                         | Feed Forward Neural Networks (cont.)                                                            |
| 21.                                         | Radial basis Function Neural networks                                                           |
| 22.                                         | Radial basis Function Neural networks (Cont.)                                                   |
| 23.                                         | Radial basis Function Neural networks (Cont.)                                                   |
| 24.                                         | Recurrent Neural Networks                                                                       |
| 25.                                         | Recurrent Neural Networks (Cont.)                                                               |
| 26.                                         | Recurrent Neural Networks (Cont.)                                                               |
| 27.                                         | Concepts of Hopfield Neural networks                                                            |
| 28.                                         | Hopfield Neural networks (Cont.)                                                                |
| 29.                                         | Electrical Equivalence of Hopfield network                                                      |
| 30.                                         | Energy function of Hopfield Network                                                             |
| 31.                                         | Weight calculation of Hopfield networks                                                         |
| 32.                                         | State updating and applications of Hopfield networks                                            |
| 33.                                         | Adaptive Resonance Theory (ART)                                                                 |
| 34.                                         | Adaptive Resonance Theory (Cont.)                                                               |
| 35.                                         | Self Organizing Feature Maps (SOM)                                                              |
| 36.                                         | Self Organizing Feature Maps (SOM) (Cont.)                                                      |
| 37.                                         | Boltzmann Machine                                                                               |
| 38.                                         | Restricted Boltzmann Machine (RBM)                                                              |
| 39.                                         | Concepts of Deep Learning and Machine learning                                                  |
| 40.                                         | Convolutional Neural networks (CNN)                                                             |
| 41.                                         | Convolutional Neural networks (CNN) (Cont.)                                                     |
| 42.                                         | CNN for Image Processing                                                                        |
| 43.                                         | Neural network Applications in Communication systems                                            |
| 44.                                         | Neural network Applications in Image Processing                                                 |
| 45.                                         | Neural network Applications in Antenna Theory                                                   |

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| Name of Program                      | B. TECH                                                                                                                                                                                                                               | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       | IoT and Applications                                                                                                                                                                                                                  |                           |                                       |
| Course Code                          | ECE 470                                                                                                                                                                                                                               |                           |                                       |
| Core / Elective / Other              | Elective                                                                                                                                                                                                                              |                           |                                       |
| Prerequisite:                        |                                                                                                                                                                                                                                       |                           |                                       |
| 1.                                   | Fundamentals of computer network,                                                                                                                                                                                                     |                           |                                       |
| 2.                                   | wireless sensor network, communication & internet technology                                                                                                                                                                          |                           |                                       |
| 3.                                   | web technology, information security                                                                                                                                                                                                  |                           |                                       |
| Course Outcomes:                     |                                                                                                                                                                                                                                       |                           |                                       |
| 1.                                   | CO1 - Understand the concepts of Internet of Things                                                                                                                                                                                   |                           |                                       |
| 2.                                   | CO2 - Analyze basic protocols in wireless sensor network                                                                                                                                                                              |                           |                                       |
| 3.                                   | CO3 - Design IoT applications in different domain & be able to analyze their performance                                                                                                                                              |                           |                                       |
| 4.                                   | CO – 4 Implement basic IoT applications on embedded platform                                                                                                                                                                          |                           |                                       |
| Description of Contents in brief:    |                                                                                                                                                                                                                                       |                           |                                       |
| 1.                                   | Introduction to IoT: M2M to IoT M2M vs IoT, An Architectural Overview, IoT Reference Architecture, Domain specific applications of IoT, Developing IoT solutions Internet of Things Privacy, Security and Governance.                 |                           |                                       |
| List of Text Books:                  |                                                                                                                                                                                                                                       |                           |                                       |
| 1.                                   | Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014. |                           |                                       |
| 2.                                   | Internet of Things (A Hands-on-Approach), by Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014.                                                                                                                               |                           |                                       |
| 3.                                   | Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, 1st Edition, Apress Publications                                                                                                 |                           |                                       |
| List of Reference Books:             |                                                                                                                                                                                                                                       |                           |                                       |
| 1.                                   | Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014. |                           |                                       |
| 2.                                   | Internet of Things (A Hands-on-Approach), by Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014.                                                                                                                               |                           |                                       |
| 3.                                   | Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, 1st Edition, Apress Publications                                                                                                 |                           |                                       |
| URLs:                                |                                                                                                                                                                                                                                       |                           |                                       |
| 1.                                   |                                                                                                                                                                                                                                       |                           |                                       |
| 2.                                   |                                                                                                                                                                                                                                       |                           |                                       |
| 3.                                   |                                                                                                                                                                                                                                       |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                                                                       |                           |                                       |
| Lecture No.                          | Topic                                                                                                                                                                                                                                 |                           |                                       |

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| <b>1 - 5</b>   | <b>Introduction to IoT</b><br>Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs                                                                      |
| <b>6-10</b>    | <b>IoT&amp; M2M</b><br>Machine to Machine, Difference between IoT and M2M, Software define Network                                                                                                                                            |
| <b>11-20</b>   | <b>Network &amp; Communication aspects</b><br>Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination                                              |
| <b>21- 28</b>  | <b>Challenges in IoT</b><br>Design challenges, Development challenges, Security challenges, Other challenges                                                                                                                                  |
| <b>29 - 34</b> | <b>Domain specific applications of IoT</b><br>Home automation, Industry applications, Surveillance applications, Other IoT applications                                                                                                       |
| <b>34- 40</b>  | <b>Developing IoTs</b><br>Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python |

|                                      |                                                                                                                                                                                                                             |                     |                           |                                       |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------|---------------------------------------|
| Name of Program                      |                                                                                                                                                                                                                             | BTECH               | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                       |                                                                                                                                                                                                                             | Internet Technology |                           |                                       |
| Course Code                          |                                                                                                                                                                                                                             | ECE 471             |                           |                                       |
| Core / Elective / Other              |                                                                                                                                                                                                                             | Elective            |                           |                                       |
| Prerequisite:                        |                                                                                                                                                                                                                             |                     |                           |                                       |
| 1.                                   | Basic knowledge of Computers                                                                                                                                                                                                |                     |                           |                                       |
| 2.                                   | Computer architecture                                                                                                                                                                                                       |                     |                           |                                       |
| 3.                                   | Network security                                                                                                                                                                                                            |                     |                           |                                       |
| Course Outcomes:                     |                                                                                                                                                                                                                             |                     |                           |                                       |
| 1.                                   | To get familiar with basics of the Internet Programming                                                                                                                                                                     |                     |                           |                                       |
| 2.                                   | To acquire knowledge and skills for creation of web site considering both client and server side                                                                                                                            |                     |                           |                                       |
| 3.                                   | To gain ability to develop responsive web applications                                                                                                                                                                      |                     |                           |                                       |
| 4.                                   | To explore different web extensions and web services standards                                                                                                                                                              |                     |                           |                                       |
| Description of Contents in brief:    |                                                                                                                                                                                                                             |                     |                           |                                       |
| 1.                                   | Internetworking: - Internet reference model and Protocols. Transmissions media, Internet devices: Hub, Switch, Router, Gateway, Border Gateway Protocol, SMTP. Introduction to LAN, WLAN, WiMAX, LTE, IEEE802.xx standards. |                     |                           |                                       |
| 2.                                   | Introduction to Servers, Proxy Servers, Client-server interaction, Browser architecture, Search Engine, Online transaction issues. Internet of Things (IOT),                                                                |                     |                           |                                       |
| 3.                                   | Network Management System:- NMS, OSI network management model, MIT, MIB, ASN.1, SNMP                                                                                                                                        |                     |                           |                                       |
| 4.                                   | Introduction to Cloud computing, Voice over IP (VoIP), Remote Access: Telnet, Remote Desktop connection, Assignment: Android Application development.                                                                       |                     |                           |                                       |
| List of Text Books:                  |                                                                                                                                                                                                                             |                     |                           |                                       |
| 1.                                   | Computer Networks and Internet, 4th Edition D.E.Comer                                                                                                                                                                       |                     |                           |                                       |
| 2.                                   | Internet Technologies, Applications and Societal Impact WojciechCellary, ArunIyengar                                                                                                                                        |                     |                           |                                       |
| List of Reference Books:             |                                                                                                                                                                                                                             |                     |                           |                                       |
| 1.                                   | Internet and World Wide Web” 4th edition Paul J. Deitel, Harvey M. Deitel                                                                                                                                                   |                     |                           |                                       |
| 2.                                   | Network Management: Principles and Practice Mani Subramanian                                                                                                                                                                |                     |                           |                                       |
| URLs:                                |                                                                                                                                                                                                                             |                     |                           |                                       |
| 1.                                   | <a href="https://www.scss.tcd.ie/owen.conlan/CS7062/1_Web_Technologies_Handout.pdf">https://www.scss.tcd.ie/owen.conlan/CS7062/1_Web_Technologies_Handout.pdf</a>                                                           |                     |                           |                                       |
| 2.                                   | <a href="http://www.ddegjust.ac.in/studymaterial/msc-cs/ms-18.pdf">http://www.ddegjust.ac.in/studymaterial/msc-cs/ms-18.pdf</a>                                                                                             |                     |                           |                                       |
| Lecture Plan (about 40-50 Lectures): |                                                                                                                                                                                                                             |                     |                           |                                       |
| Lecture No.                          | Topic                                                                                                                                                                                                                       |                     |                           |                                       |
| 1.                                   | Internetworking                                                                                                                                                                                                             |                     |                           |                                       |
| 2.                                   | Internet reference model                                                                                                                                                                                                    |                     |                           |                                       |

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|-----|---------------------------------------------|
| 3.  | Protocols                                   |
| 4.  | Transmissions media                         |
| 5.  | Internet devices                            |
| 6.  | Hub, Switch                                 |
| 7.  | Tutorial-1                                  |
| 8.  | Router                                      |
| 9.  | Gateway                                     |
| 10. | Border                                      |
| 11. | Gateway Protocol                            |
| 12. | SMTP                                        |
| 13. | Tutorial-2                                  |
| 14. | Introduction to LAN, WLAN                   |
| 15. | WiMAX, LTE                                  |
| 16. | IEEE802.xx standards                        |
| 17. | Introduction to Servers                     |
| 18. | Proxy Servers                               |
| 19. | Client-server interaction                   |
| 20. | Browser architecture                        |
| 21. | Search Engine                               |
| 22. | Online transaction issues                   |
| 23. | Tutorial-3                                  |
| 24. | Internet of Things (IOT)-1                  |
| 25. | Internet of Things (IOT)-2                  |
| 26. | Internet of Things (IOT)-3                  |
| 27. | Internet of Things (IOT)-4                  |
| 28. | Network Management System:- NMS             |
| 29. | OSI network management model                |
| 30. | MIT                                         |
| 31. | MIB                                         |
| 32. | ASN.1, SNMP                                 |
| 33. | Introduction to Cloud computing, ..         |
| 34. | Voice over IP (VoIP)                        |
| 35. | Remote Access                               |
| 36. | Telnet,                                     |
| 37. | Remote Desktop connection                   |
| 38. | Assignment: Android Application development |
| 39. | Routing algorithm                           |
| 40. | Tutorial-4                                  |

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| Name of Program                                                               | B.Tech (Electronics & communications)                                                                                                                                                         | Semester V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                                                                | Probability Theory and Random Process                                                                                                                                                         |                        |                                       |
| Course Code                                                                   | ECE 472                                                                                                                                                                                       |                        |                                       |
| Core / Elective / Other                                                       | Elective                                                                                                                                                                                      |                        |                                       |
| Prerequisite:                                                                 |                                                                                                                                                                                               |                        |                                       |
| 1.                                                                            | NIL                                                                                                                                                                                           |                        |                                       |
| Course Outcomes: After completion of the course, the students will be able to |                                                                                                                                                                                               |                        |                                       |
| CO1                                                                           | Understand the concept of probability theory, random variables, and density functions                                                                                                         |                        |                                       |
| CO2                                                                           | Apply the concept of standard density functions for different engineering problems                                                                                                            |                        |                                       |
| CO3                                                                           | Create the probabilistic models for prediction for different types of data related problems including engineering, economical and social data                                                 |                        |                                       |
| Description of Contents in brief:                                             |                                                                                                                                                                                               |                        |                                       |
| 1.                                                                            | Fundamentals of probability theory and random processes, axiomatic probability theory; discrete and continuous random variables;                                                              |                        |                                       |
| 2.                                                                            | Distribution and density functions and Operations on One Random Variable. Expected value of a random variable, function of a random variable. Inequalities.                                   |                        |                                       |
| 3.                                                                            | Multiple Random Variables and Operations on Multiple Random Variables.                                                                                                                        |                        |                                       |
| 4.                                                                            | The Stochastic process Concept, Deterministic and Nondeterministic Processes, Statistical Independence and concept of Stationarity: Time Averages and 1 Ergodicity Correlation Functions      |                        |                                       |
| 5.                                                                            | Spectral representation; Gaussian processes; Poisson and birth-death processes; Markov chains; random walks, Brownian motion,                                                                 |                        |                                       |
| List of Text Books:                                                           |                                                                                                                                                                                               |                        |                                       |
| 1.                                                                            | Probability Theory and Random Processes by P. Ramesh Babu, TMH 2017                                                                                                                           |                        |                                       |
| 2.                                                                            | Probability and Random Processes by Palaniammal S, PHI 2011                                                                                                                                   |                        |                                       |
| 3.                                                                            | Probability and Random Processes-Scott Miller, Donald Childers,2Ed,Elsevier,2012                                                                                                              |                        |                                       |
| List of Reference Books:                                                      |                                                                                                                                                                                               |                        |                                       |
| 1.                                                                            | Probability and Random Processes with Application to Signal Processing - Henry Stark and John W. Woods, Pearson Education, 3rd Edition.                                                       |                        |                                       |
| 2.                                                                            | Probability, Random Variables and Stochastic Processes Athanasios Papoulis and S.Unnikrishna Pillai, PHI, 4th Edition, 2002.                                                                  |                        |                                       |
| 3.                                                                            | Statistical Theory of Communication -S.P. Eugene Xavier, New Age Publications 2003                                                                                                            |                        |                                       |
| 4.                                                                            | Probability Methods of Signal and System Analysis- George R. Cooper, Clave D. MC Gillem, Oxford, 3rd Edition, 1999                                                                            |                        |                                       |
| URLs:                                                                         |                                                                                                                                                                                               |                        |                                       |
| 1.                                                                            | <a href="https://www.youtube.com/watch?v=1uW3qMFA9Ho&amp;list=PLU14u3cNGP60hI9ATjSFgLZpbNJ7myAg6">https://www.youtube.com/watch?v=1uW3qMFA9Ho&amp;list=PLU14u3cNGP60hI9ATjSFgLZpbNJ7myAg6</a> |                        |                                       |
| 2.                                                                            | <a href="https://www.youtube.com/watch?v=soZRfdnkUQg">https://www.youtube.com/watch?v=soZRfdnkUQg</a>                                                                                         |                        |                                       |
| 3.                                                                            | <a href="https://www.youtube.com/watch?v=eDS8MnQMgg0">https://www.youtube.com/watch?v=eDS8MnQMgg0</a>                                                                                         |                        |                                       |
| Lecture Plan (about 40-50 Lectures):                                          |                                                                                                                                                                                               |                        |                                       |
| Lectu                                                                         | Topic                                                                                                                                                                                         |                        |                                       |

| re No. |                                                                                                                    |
|--------|--------------------------------------------------------------------------------------------------------------------|
| 1.     | Set theory, Experiments and Sample Spaces, Discrete and Continuous Sample Spaces                                   |
| 2.     | Events, Probability Definitions and Axioms                                                                         |
| 3.     | Mathematical Model of Experiments, Joint Probability                                                               |
| 4.     | Conditional Probability, Total Probability                                                                         |
| 5.     | Bayes Theorem, and Independent Events, Bernoulli's trials.                                                         |
| 6.     | Definition of a Random Variable, Conditions for a Function to be a Random Variable                                 |
| 7.     | Discrete and Continuous, Mixed Random Variable                                                                     |
| 8.     | Distribution and Density functions, Properties                                                                     |
| 9.     | Binomial and Poisson distributions                                                                                 |
| 10.    | Uniform, Exponential Gaussian, Rayleigh distributions                                                              |
| 11.    | Methods of defining Conditioning Event, Conditional Density function and its properties,                           |
| 12.    | Expected value of a random variable, function of a random variable                                                 |
| 13.    | Moments about the origin, central moments, variance and skew                                                       |
| 14.    | Characteristic function, moment generating function, transformations of a random variable,                         |
| 15.    | Monotonic transformations for a continuous random variable, transformations of Discrete random variable            |
| 16.    | Inequalities, Markov Inequality                                                                                    |
| 17.    | Chebyshev Inequality                                                                                               |
| 18.    | Multiple Random Variables: Vector Random Variables,                                                                |
| 19.    | Joint Distribution Function and Properties,                                                                        |
| 20.    | Joint density Function and Properties,                                                                             |
| 21.    | Marginal Distribution and density Functions,                                                                       |
| 22.    | Conditional Distribution and density Functions, Statistical Independence,                                          |
| 23.    | Distribution and density functions of Sum of Two or Several Random Variables,                                      |
| 24.    | Central Limit Theorem                                                                                              |
| 25.    | Expected Value of a Function of Random Variables,                                                                  |
| 26.    | Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions                              |
| 27.    | Jointly Gaussian Random Variables: Two and N Random Variable case                                                  |
| 28.    | Transformations of Multiple Random Variables                                                                       |
| 29.    | The Stochastic process Concept, Classification of Processes, Deterministic and Nondeterministic Processes,         |
| 30.    | Distribution and Density Functions, Statistical Independence and concept of Stationarity                           |
| 31.    | First-Order Stationary Processes, SecondOrder and Wide-Sense Stationarity,                                         |
| 32.    | Nth-Order and Strict-Sense Stationarity, Time Averages and 1 Ergodicity                                            |
| 33.    | Mean-Ergodic Processes, Correlation-Ergodic Processes Autocorrelation Function and Its Properties                  |
| 34.    | Cross-Correlation Function and Its Properties, Covariance Functions and its properties, Gaussian Random Processes. |
| 35.    | Mean and Mean-squared value, Autocorrelation, Cross-Correlation Functions.                                         |
| 36.    | The Power Spectrum and its Properties, Relationship between Power Spectrum and Autocorrelation Function,           |
| 37.    | Cross-Power Density Spectrum and Properties                                                                        |
| 38.    | Relationship between Cross-Power Spectrum and Cross-Correlation Function                                           |

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| <b>39.</b> | Power density spectrum of response, cross power spectral density of input and output of a linear system |
| <b>40.</b> | Gaussian processes; Poisson and birth-death processes; Markov chains; random walks, Brownian motion,    |

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| Name of Program                                                               | B.Tech (Electronics & communications)                                                                                                                                                                                                                                     | Semester<br>V/VI/VII/VIII | Year 3 <sup>rd</sup> /4 <sup>th</sup> |
| Name of Course                                                                | Artificial Intelligence and Machine Learning                                                                                                                                                                                                                              |                           |                                       |
| Course Code                                                                   | ECE 473                                                                                                                                                                                                                                                                   |                           |                                       |
| Core / Elective / Other                                                       | Elective                                                                                                                                                                                                                                                                  |                           |                                       |
| Prerequisite:                                                                 |                                                                                                                                                                                                                                                                           |                           |                                       |
| 1.                                                                            | Basic knowledge of probability                                                                                                                                                                                                                                            |                           |                                       |
| Course Outcomes: After completion of the course, the students will be able to |                                                                                                                                                                                                                                                                           |                           |                                       |
| CO1                                                                           | Devise different machine learning models based on the understanding of AI and types of machine learning (ML).                                                                                                                                                             |                           |                                       |
| CO2                                                                           | Apply the supervised classification methods to classify data having feature vectors and class labels.                                                                                                                                                                     |                           |                                       |
| CO3                                                                           | Evaluate the performance of classification, regression, dimension reduction, and clustering methodologies for pattern recognition.                                                                                                                                        |                           |                                       |
| CO4                                                                           | Create a ML model that learns from training sets, and performs efficiently on test and validation sets.                                                                                                                                                                   |                           |                                       |
| Description of Contents in brief:                                             |                                                                                                                                                                                                                                                                           |                           |                                       |
| 1.                                                                            | Basics of Artificial Intelligence (AI), Machine Learning (ML), and Pattern Recognition, Neural Network, Deep Learning, and Generative Networks. Data Science Introduction. ML design cycle, Types of learning, Classifiers. Standard and multi-dimensional PDFs and PMFs. |                           |                                       |
| 2.                                                                            | Data acquisition and pre-processing methods. Supervised learning models: KNN, SVM, Decision trees, ANNs etc.                                                                                                                                                              |                           |                                       |
| 3.                                                                            | Bayes Decision theory, Parameter estimation methods, MLE, Dimension reduction methods: PCA and LDA etc.                                                                                                                                                                   |                           |                                       |
| 4.                                                                            | Sequential data classification using HMMs and RNNs, Regression analysis: linear, polynomial regression, interpolation and extrapolation.                                                                                                                                  |                           |                                       |
| 5.                                                                            | Unsupervised learning and clustering, K-means, Hierarchical and other clustering methods, Cluster validation.                                                                                                                                                             |                           |                                       |
| List of Text Books:                                                           |                                                                                                                                                                                                                                                                           |                           |                                       |
| 1.                                                                            | R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley, 2001                                                                                                                                                                                          |                           |                                       |
| 2.                                                                            | S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009                                                                                                                                                                                     |                           |                                       |
| 3.                                                                            | C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006                                                                                                                                                                                                    |                           |                                       |
| List of Reference Books:                                                      |                                                                                                                                                                                                                                                                           |                           |                                       |
| 1.                                                                            | Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Publications.                                                                                                                                                                         |                           |                                       |
| 2.                                                                            | S. M. Ross, Introduction to Probability models, Academic Press, 2010. (for probability).                                                                                                                                                                                  |                           |                                       |
| 3.                                                                            | S. Theodoridis et al, 'Introduction to Pattern Recognition, A MATLAB Approach'. Academic Press, 2010.                                                                                                                                                                     |                           |                                       |
| 4.                                                                            | A. K. Jain et al., Statistical Pattern Recognition: A Review, January 2000.                                                                                                                                                                                               |                           |                                       |
| URLs:                                                                         |                                                                                                                                                                                                                                                                           |                           |                                       |
| 1.                                                                            | <a href="https://www.youtube.com/watch?v=KNAWp2S3w94">https://www.youtube.com/watch?v=KNAWp2S3w94</a>                                                                                                                                                                     |                           |                                       |
| 2.                                                                            | <a href="https://www.youtube.com/watch?v=y9lueF5-nEg">https://www.youtube.com/watch?v=y9lueF5-nEg</a>                                                                                                                                                                     |                           |                                       |
| 3.                                                                            | <a href="https://www.youtube.com/watch?v=aircAruvnKk&amp;t=526s">https://www.youtube.com/watch?v=aircAruvnKk&amp;t=526s</a>                                                                                                                                               |                           |                                       |

| <b>Lecture Plan (about 40-50 Lectures):</b> |                                                                                               |
|---------------------------------------------|-----------------------------------------------------------------------------------------------|
| <b>Lecture No.</b>                          | <b>Topic</b>                                                                                  |
| 1.                                          | Introduction to AI and ML                                                                     |
| 2.                                          | Introduction to Neural Network, Deep Learning, and Generative Networks.                       |
| 3.                                          | Types of learning, ML design cycle,                                                           |
| 4.                                          | Statistical pattern recognition,                                                              |
| 5.                                          | Standard PDFs and PMFs (Uniform, Normal, Exponential, Bernoulli, Binomial distributions)      |
| 6.                                          | Normal and multivariate normal distributions                                                  |
| 7.                                          | Data acquisition and pre-processing methods                                                   |
| 8.                                          | Supervised Learning Model: KNN-Inclusion of prior knowledge, data normalization, weighted KNN |
| 9.                                          | Supervised Learning Model: Linear SVM                                                         |
| 10                                          | SVM- Soft margin approach and kernel trick                                                    |
| 11                                          | Decision Tree                                                                                 |
| 12                                          | Bootstrap and Random Forest                                                                   |
| 13                                          | ANN: Biological inspiration and Perceptron                                                    |
| 14                                          | MLP                                                                                           |
| 15                                          | Backpropagation                                                                               |
| 16                                          | Bayes Theorem and Bayesian decision theory                                                    |
| 17                                          | Bayes Classifier                                                                              |
| 18                                          | Discriminant function and decision surfaces.                                                  |
| 19                                          | Introduction to parameter-estimation method and its need.                                     |
| 20                                          | Maximum Likelihood estimation                                                                 |
| 21                                          | Gaussian mixture models,                                                                      |
| 22                                          | Expectation maximization method                                                               |
| 23                                          | Bayesian estimation                                                                           |
| 24                                          | Naïve Bayes classification model                                                              |
| 25                                          | Scattering matrix and principal components                                                    |
| 26                                          | PCA for dimension reduction                                                                   |
| 27                                          | LDA for dimension reduction                                                                   |
| 28                                          | Linear discriminant function-based classifiers (SWLDA and BLDA)                               |
| 29                                          | Examples and classification methods of sequential data                                        |
| 30                                          | Markov chains                                                                                 |
| 31                                          | Hidden Markov Models for sequential data classification                                       |
| 32                                          | Recurrent NNs for sequential data classification                                              |
| 33                                          | Regression analysis: Linear regression                                                        |
| 34                                          | Polynomial regression, interpolation and extrapolation                                        |
| 35                                          | Clustering analysis                                                                           |
| 36                                          | Types of clustering                                                                           |
| 37                                          | Prototype based clustering                                                                    |
| 38                                          | K-means clustering method                                                                     |

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|-----------|--------------------------------------------|
| <b>39</b> | Hierarchical and other clustering methods, |
| <b>40</b> | Cluster validation                         |